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THE

JOURNAL

OF THE

CINCINNATI

SOCIETY OF NATURAL HISTORY.

PUBLISHING COMMITTEE:

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THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. IV. CINCINNATI, APRIL, 1881. No. 1.

PROCEEDINGS OF THE SOCIETY.

TUESDAY EVENING, *January* 6, 1881.

Dr. R. M. Byrnes, President, in the chair. Davis L. James, Secretary *pro tem.* Present, 12 members.

Prof. F. W. Clarke was elected a member of the Society.

Mr. W. M. Linney donated specimens of *Ptilodictya hilli*, a copy of his report on the timbers of Boyle and Mercer counties, Kentucky, and a specimen of the wood of *Cladrastis tinctoria*, or yellow wood, a tree not uncommon in the Alleghanies, but rare in this locality.

TUESDAY EVENING, *February* 1, 1881.

Dr. R. M. Byrnes, President, in the chair, Present, 15 members.

Dr. A. T. Keckeler, and A. V. Stewart, were elected members of the Society.

L. S. Cotton made some remarks upon the meteorological observations which have been made in this locality, and urged the importance of full and complete weather reports.

A. E. Heighway, Jr., presented specimens of native copper, tremolite, actinolite, and slikensides, from the west; and Mr. J. E. Frey presented a fine specimen of the sea sturgeon, which is splendidly mounted by Mr. Shorten.

TUESDAY EVENING, *March* 1, 1881.

Dr. R. M. Byrnes, President, in the chair. L. S. Cotton, Secretary *pro tem.* Present, 20 members.

Joseph F. James read a paper on the geographical distribution of plants, etc., which is published elsewhere in this No. of the JOURNAL.

Dr. A. J. Howe exhibited a drawing (one tenth of the natural size) of the whale on exhibition in this city. He showed that it had been erroneously called the Greenland or Right whale, whereas it is the *Balœnoptera boops*, or fin-whale, or rorqual of the Norwegians, a mammal not less interesting than the true *Balœna*, though of much less value both for oil and *baleen.* He described its peculiarities in a very interesting address, that was warmly received by the members present.

S. A. Miller made some remarks upon the glacial theory, taking the position that the so-called continental glacier and glacial period of this continent are purely the work of the imagination, and are not founded upon any of the known geological facts. He followed the views of Dawson respecting the Pliocene period, in the region of the Gulf of St. Lawrence, Lake Champlain, Hudson river, and the New England States, and showed that the drift of the central part of the Continent was not connected with the drift of the eastern part, and therefore not, necessarily, contemporaneous with it. He dwelt upon the absence of drift phenomena in the Rocky mountain region, and claimed that the castellated rocks of the Bad Lands of the west, and the outliers of pinnacled sandstone, in Wisconsin and other parts of the country, are unimpeachable witnesses, bearing lasting testimony against the continental glacier and the so-called glacial period.

Dr. O. D. Norton announced that Geo. Graham, a life member of the Society, had that evening departed this life, and on motion of Dr. A. J. Howe, a committee, consisting of Dr. A. J. Howe, Dr. O. D. Norton, and U. P. James, was appointed to draft suitable expressions of the esteem in which he was held by the Society, and such remarks upon his life and character as might seem desirable. On motion of V. T. Chambers, the committee were authorized to place their report in the hands of the publishing committee, for appearance in this number of the JOURNAL, without waiting to have it first read to the Society and entered on the journal.

Prof. Mickleborough presented a Cephalopod from near Provincetown, Massachusetts.

THE CÆNOZOIC AGE OR TERTIARY PERIOD.

By S. A. Miller, Esq.

[*Continued from Vol. iii., page 288.*]

In 1858, Dr. F. V. Hayden* prepared a vertical section, showing the order of superposition of the different beds of the Tertiary Basin of White and Niobrara rivers. The Miocene, he divided, in ascending order, as follows:

1. *Bed A.*—Light gray, fine sand, with more or less calcareous matter, passing down into an ash-colored plastic clay, with large quantities of quartz grains disseminated through it, sometimes forming aggregated masses like quartzose sandstone cemented with plaster; then an ash-colored clay with a greenish tinge, underlaid at base by a light gray and ferruginous silicious sand and gravel, with pinkish bands. Immense quantities of silex, in the form of seams, all through the beds. Titanotherium Bed. Found on Old Woman's creek, and in many localities along the valley of the South Fork of Shyenne. Best development on Sage and Bear creeks. Seen at several localities in the valley of White river. Thickness, 80 to 100 feet.

2. *Bed B.*—A deep flesh-colored, argillo-calcareous, indurated grit; the outside, when weathered, has the appearance of a plastic clay. Passes down into a gray clay, with layers of sandstone; underlaid by a flesh-colored, argillo-calcareous stratum, containing a profusion of Mammalian and Chelonian remains. Turtle and Oreodon Bed. Found on Old Woman's creek, a fork of Shyenne river, on the head of the South Fork of the Shyenne; most conspicuous on Sage and Bear creeks, and at Ash Grove Spring, and well developed in numerous localities in the valley of White river. Thickness, 80 to 100 feet.

3. *Bed C.*—Very fine, yellow, calcareous sand, not differing very materially from Bed D, with numerous layers of concretions, and rarely organic remains, passing down into a variegated bed, consisting of alternate layers of dark brown clay, and light gray, calcareous grit, forming bands, of which twenty-seven were counted at one locality, from one inch to two feet in thickness. Found on White river, Bear creek, Ash Grove Spring and head of Shyenne river, but most conspicuous near White river. Thickness, 50 to 80 feet.

4. *Bed D.*—A dull, reddish-brown, indurated grit, with many layers of silico-calcareous concretions, sometimes forming a heavy-bedded,

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* Proc. Acad. Nat. Sci., vol. x.

fine-grained sandstone, and containing comparatively few organic remains. Found on the Niobrara and Platte rivers; well developed in the region of Fort Laramie, and in the valley of White river; and conspicuous, and composing the main part of the dividing ridge between White and Niobrara rivers. Thickness, 350 to 400 feet.

5. *Bed E.*—Usually a coarse-grained sandstone, sometimes heavy bedded and compact; sometimes loose and incoherent, and varying much in different localities. It forms immense masses of conglomerate, and contains layers of tabular limestone, with indistinct organic remains, and a few mammalian remains, in a fragmentary condition. It passes gradually into the bed below. It is most fully developed along the upper portion of Niobrara river, and in the region around Fort Laramie. It is seen also on White river, and on Grindstone hills. Thickness from 180 to 200 feet.

The Pliocene consists of 1st, dark gray or brown sand, loose, incoherent, with remains of mastodon and elephant; 2d, sand and gravel, incoherent; 3d, yellowish-white grit, with many calcareous, arenaceous concretions; 4th, gray sand with a greenish tinge, which contains the greater part of the organic remains; 5th, deep yellowish-red arenaceous marl; 6th, yellowish-gray grit, sometimes quite calcareous, with numerous layers of concretionary limestone, from two to six inches in thickness, containing fresh water and land shells, closely allied, and perhaps identical with living species, which belong to the genera, *Succinea*, *Limnea*, *Paludina* and *Helix.* It contains also, much wood of coniferous character. It covers a very large area on Loup Fork, from the mouth of North Branch to the source of Loup Fork, and occurs in the Platte valley. It is most fully developed on the Niobrara river, and extends from the mouth of Turtle river three hundred miles up the Niobrara. It occurs on Bijou hills, and Medicine hills, and is thinly represented in the valley of White river. Thickness from 300 to 400 feet.

The Post-pliocene consists of yellow, silicious marl, similar in its character to the loess of the Rhine, passing down into variegated indurated clays, and brown and yellow fine grits. It contains the remains of extinct quadrupeds, mingled with those identical with recent ones, and a few mollusca, mostly identical with recent species. It is most fully developed along the Missouri river, from the mouth of the Niobrara to St. Joseph, and occurs in the Platte valley and on the Loup Fork. Thickness from 300 to 500 feet.

Prof. G. C. Swallow* referred a formation made up of clays and

* Proc. Am. Ass. Ad. Sci.

sands and sandstone, extending along the bluffs, and skirting the bottoms, from Commerce, in Scott county, Missouri, westward to Stoddard, and thence south to the chalk bluffs in Arkansas to the Tertiary age. His section shows a thickness of 214 feet, but no fossils were obtained.

Prof. E. Emmons* described, from the Eocene of Craven county, North Carolina, *Carcharodon ferox*, *Cidaris carolinensis*, *Echinolampus appendiculatus*, *Echinocyamus parvus;* from near Newbern, *Carcharodon triangularis*, *Trygon carolinensis;* from Wilmington, *Carcharodon crassidens*, *C. contortidens*, *Cidaris mitchelli*, *Gonioclypeus subangulatus*, *Lunulites oblongus;* and from other places, *Hemipristis crenulatus.*

He described, from the Miocene at Elizabethtown, and near Cape Fear river, Bladen county, North Carolina, *Polyptychodon rugosus*, *Elliptonodon compressus*, *Fusus æqualis*, *F. lamellosus*, *F. moniliformis*, *Fasciolaria elegans*, *F. alternata*, *F. acuta*, *F. nodulosa*, *F. sparrowi*, *Cancellaria carolinensis*, *Buccinum moniliforme*, *B. multilineatum*, *Voluta obtusa*, *Paludina subglobosa;* and from the marl of other places, *Galeocerdo sub-crenatus*, *Pycnodus carolinensis*, *Terebra neglecta*, *Dolium octocostatum*, *Marginella constricta*, *M. elevata*, *Pleurotoma elegans*, *P. flexuosum*, *P. tuberculatum*, *Pyramidella reticulata*, *Chemnitzia reticulata*, *Eulima subulata*, *Cerithium annulatum*, *C. bicostatum*, *Terebellum constrictum*, *Scalaria curta*, *Littorina lineata*, *Delphinula quadricostata*, now *Carinorbis quadricostatus*, *Tornatina cylindrica*, *Cæcum annulatum*, *Pecten princepoides*, *Chama striata*, and *Artemis transversus.*

Prof. F. S. Holmes† described, from the Post Pliocene of South Carolina, *Nodosaria obtusa*, *Astræa crassa*, *Pectunculus charlestonensis*, *Lucina kiawahensis*, *Tapes grus*, *Mulinia milesi*, *Mesodesma concentricum*, *Abra angulata*, *Mya simplex*, *Cavolina tuomeyi*, *Fusus conus*, *F. filiformis*, *F. bullata*, *F. rudis*, *Volutomitra wandoensis*, *Turbonilla cancellata*, *T. quinquestriata*, *T. lineata*, *T. subulata*, *T. caroliniana*, *T. acicula*, *T. subcoronata*, *Obeliscus crenulatus*, *Architectonica gemma*, *Angaria crassa*, and *Adeorbis nautiliformis.*

Dr. B. F. Shumard‡ described, from rocks supposed to be of Eocene age, at Port Orford and at Davis' Coal Mine in Oregon Territory, *Lucina fibrosa*, *Corbula evansana*, *Leda oregona*, now *Nuculana ore-*

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* Geo. Sur. N. Carolina.

† Post Pliocene Fossils of South Carolina.

‡ Trans. St. Louis Acad. Sci., vol. i.

gona, *L. willamettensis*, now *N. willamettensis;* and from gray, fine-grained sandstone, at the mouth of Coose Bay, *Pecten coosensis*, and *Venus securis.*

Dr. Leidy* described, from the Pliocene of the Niobrara river, Nebraska, *Mastodon mirificus*, *Procamelus gracilis*, *P. robustus*, *P. occidentalis*, *Canis haydeni*, *C. sævus*, *C. temerarius*, *C. vafer*, *Felis intrepidus*, now *Pseudælurus intrepidus*, *Aelurodon ferox*, *Hystrix venustus*, *Castor tortus*, *Cervus warreni*, *Megalomeryx niobrarensis*, *Merychyus elegans*, *M. major*, *M. medius*, *Hypohippus affinis*, *Parahippus cognatus*, *Equus excelsus*, *E. fraternus*, *Protohippus perditus*, *Merychippus mirabilis*, *Rhinoceros crassus*, *Euelephas imperator*, and from the red grit bed of Niobrara, near Fort Laramie (Miocene), *Merycochoerus proprius.*

In 1859, James Richardson† made a geological examination of the Gaspe peninsula, and observed two terraces in the drift to the west of Trois Pistoles river, at 130 and 300 feet, respectively, above the sea, and another at the mouth of the Matanne, at the height of 50 feet. Stratified clay occurs at the head of lake Matapedia, 480 feet above the sea and near the outlet at the height of about 530 feet. Marine testacea occur in the terrace on the east side of the Matanne river at the height of 50 feet above the sea; about two miles west of the Metis river, at the height of 130 feet, and eight miles up the Metis river, at 245 feet above the sea. At the St. Anne river there are five or six terraces in a height of 25 feet, abounding in fragments of marine shells. Grooves and scratches were observed a half mile below Trois Pistoles church, 60 feet above the sea, bearing S. 32 deg. E., and on the Kempt road, two miles from Lake Matapedia, 630 feet above the sea, and bearing S. 80 deg. E.

W. E. Logan‡ explored the river Rouge, a branch of the Ottawa, to the Iroquois Chute, about fifty miles from the mouth. He found an undisturbed deposit of clay on the left bank of the river, on the fourth range of Grenville, 280 feet above Lake St. Peter. In the rear of Grenville and front of Harrington, not far east of the Rouge, there spreads out a flat surface of several hundred acres in extent, which is underlaid by clay, and has a height of about 500 feet above Lake St. Peter. The plain of the three mountains has an elevation above the ordinary summer level of the river, of about 30 feet, and above Lake St. Peter of

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* Proc. Acad. Nat. Sci., vol. x.
† Rep. of Progr. Geo. Sur. of Canada.
‡ Geo. Sur. of Canada, Rep. of Progress.

about 585 feet. It consists, in general, of sand or fine gravel at the top, with clay interstratified toward the lower part, but the sand greatly predominates. The surface of the rocks in the valley wherever examined were found to be grooved and striated. The courses of the grooves vary from S. 30 deg. E. to S. 25 deg. W., and accord in a general way, with the direction of the valley. The limits of the valley evidently guided the direction of the moving masses which produced the striæ.

Prof. Leo Lesquereux* described, from the Pliocene near Sommerville, Fayette county, Tennessee, *Salix densinervis*, *Quercus saffordi*, *Andromeda dubia*, and *Elæagnus inæqualis.*

In 1860, Prof. E. W. Hilgard† divided the Tertiary of Mississippi in ascending order into, 1st, The Northern Lignitic Group; 2d, The Claiborne Group; 3d, The Jackson Group; 4th, the Vicksburg Group; 5th, The Grand Gulf Group.

The Northern Lignitic Group occupies the central part of Northern Mississippi, and though generally covered by later deposits it outcrops at numerous places and is found at all deep borings. It consists of estuary deposits of sandstone, with marine shells; gray clays and sands, and dark brown and yellow clays and sands with lignite. Estimated thickness, including the Claiborne Group, 425 feet.

The Claiborne Group is found in the central part of the northern half of the State, in Holmes, Atala, Carroll and Choctaw counties, and in the western part of the State in Clarke, Lauderdale, Newton and Scott counties. It consists of blue and white marls, the latter always sandy and often indurate, and sandstones and claystones with sometimes lignitic clays and sands.

The Jackson Group forms a band across the central part of the State through Wayne, Clarke, Jasper, Newton, Scott, Madison and Yazoo counties. It consists of white (often indurate) and blue marls, highly fossiliferous. Estimated thickness, 80 feet.

The Vicksburg Group is the highest of the marine Eocene, and the only one which reaches the Mississippi river. It occupies a narrow belt of nearly uniform width, south of the Jackson Group, and extending across the State from Vicksburg to the Alabama line, and thence to the Tombigbee river, where it forms the bluff at St. Stephens. It consists of crystalline limestones and blue marls with ferruginous strata. It is the only one of the marine stages of the Eocene which

* Am. Jour. Sci. & Arts, 2d ser., vol. xxvii.

† Geo. of Miss.

exhibits crystalline limestones. It is highly fossiliferous. Estimated thickness, including the lignite at its base, 112 feet.

The Grand Gulf Group covers an immense extent of country south of the Vicksburg Group, and is composed essentially of clays and sandstones, the latter generally rather aluminous and soft, and of white-gray and yellowish-gray tints; the sand being very sharp. It takes its name from the bluff at Grand Gulf on the Mississippi river, where it is well exposed. It is overlaid near the coast by strata of Pliocene and Post-pliocene age. Estimated thickness, 150 feet.

Prof. F. S. Holmes* made three vertical sections of the Post-pliocene strata of South Carolina in descending order as follows:

1. The marine bed of the Wadmalur, consisting of yellow sand, 15 feet; ferruginous sand with casts of shells, 2 feet; red clay, 2 feet; and gray sand and mud with comminuted shells and fossils in fine preservation, 3½ feet.

2. The Ashley river beds, consisting of yellow sands with bands of ferruginous clay, 4 feet, and blue mud resting on the white Eocene marl, 1 foot.

3. The Goose creek beds, consisting of yellow sand, 12 feet; blue mud, 2 feet; ferruginous sand containing bones, 3 inches; yellow sand, 3 feet; and Pliocene marl resting on the Eocene white marl, 12 feet.

The fossil bones obtained from these strata are often in a fine state of preservation, especially those taken from the blue mud, which are generally petrified; those from the sands are likewise well preserved, but in the peaty or upper beds they are not so petrified, retain all their gelatin and appear to decompose rapidly. They consist of the bones of horses, hogs, dogs, rabbits, beavers, the tapir, and other mammalian remains.

T. A. Conrad† described, from the Eocene of Alabama and Mississippi, *Exilia pergracilis*, *Volutilithes limopsis*, *V. rugatus*, *Athleta leioderma*, *Simpulum showwalteri*, *S. autopsis*, *S. exilis*, *Galeodia tricarinata*, *Cithara nereidis*, *Murex morulus*, *Pseudoliva tuberculifera*, *Scala lintea*, *S. octolineata*, *S. staminea*, *Actæonina subvaricata*, *Tornatellæa bella*, *Cerithioderma prima*, *Mazzalina pyrula*, *Leda bella*, now *Nuculana bella*, *L. eborea*, now *N. eborea*, *Axinæa bellisculpta*, *Diplodonta astartiformis*, *D. deltoidea*, *Crenella latifrons;* from Texas, *Pseudoliva carinata*, *P. fusiformis*, *P. linosa*, *P. perspectiva*, and *Monoptygma crassiplica*.

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* Proc. Acad. Nat. Sci., vol. ii., and in Post-pliocene Foss. S. Carolina.

† Jour. Acad. Nat. Sci., 2d ser., vol. iv.

Wm. M. Gabb described, from the Eocene at Wheelock, and in Caldwell county, Texas, *Belosepia ungula*, *Odontopolys compsorhytis*, *Fusus mortoniopsis*, *Neptunea enterogramma*, *Turris moorei*, *T. kelloggi*, now *Surcula kelloggi*, *T. nodocarinata*, now *Surcula nodocarinata*, *T. retifera*, *T. texana*, *Eucheilodon reticulatum*, *Scobinella crassiplicata*, *S. læviplicata*, *Distortio septemdentata*, *Phos texanus*, *Agaronia punctulifera*, now *Olivula punctulifera*, *Fasciolaria polita*, *F. moorei*, now *Cordiera moorei*, *Cymbiola texana*, *Mitra exilis*, *M. mooreana*, now *Lapparia mooreana*, *Erato semenoides*, now *Marginella semenoides*, *Neverita arata*, *Lunatia moorei*, *Architectonica meekana*, *A. texana*, *A. vespertina*, *Spirorbis leptostoma*, *Turritella nasuta*, *Eulima exilis*, *E. tenua*, *Dentalium minutistriatum*, *Ditrupa subcoarctata*, now *Gadus subcoarctatus*, *Bulla kelloggi*, *Volvula conradana*, *V. minutissima*, *Helcion leanus*, *Corbula texana*, *Tellina mooreana*, *Leda compsa*, now *Nuculana compsa*, *Noetia pulchra*, *Crassatella antestriata*, *Anomia aphippioides*, *Serpula texana;* from Alabama, *Cirsotrema megaptera*, *Leiorhinus crassilabris*, *Axinæa intercostata*, and *Pecten spillmani.*

He described, from the Miocene, near Shiloh, New Jersey, *Cantharus cumberlandana*, *Fasciolaria woodi*, *Natica hemicrypta*, *Mercenaria cancellata*, and from Maurice river, New Jersey, *Ostrea mauricensis.*

Gabb and Horn described, from the Eocene, in Caldwell county. Texas, *Flabellum pachyphyllum* and *Trochosmilia mortoni.*

Prof. Leo Lesquereux* described, from the lower Eocene or lignitic Tertiary of Tennessee and Mississippi, *Magnolia hilgardana* and *Rhamnus marginatus.*

Meek and Hayden† described, from the Miocene of the Bad Lands of White river, *Planorbis leidyi* and *P. vetulus.*

Prof. J. W. Dawson‡ described, from the Pliocene of Labrador, the foraminifer, *Nonionina labradorica.*

In 1861, Prof. C. H. Hitchcock§ said that there is not a mountain in Maine, fragments of which will not be found scattered over the country to the south or southeast. The granite of the Katahdin region is scattered over the southern part of Penobscot county, and the rocks of Mt. Abraham and Mt. Blue may be recognized among the bowlders in Kennebec county. One of the effects of the drift action is the smooth-

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* Geo. of Ark., vol. ii.

† Proc. Acad. Nat. Sci.

‡ Can. Nat. and Geo., vol. v.

§ Rep. Geo. Maine.

ing, rounding, scratching and furrowing of the ledges over which the drift materials have passed, and unless these ledges have been decomposed upon their surfaces, they are covered with scratches or striæ, usually parallel to one another, and indicating the course of the drift agency. Ledges of talcose and argillaceous rocks preserve these markings the most distinctly. Were the rocks of Maine laid bare, fully half the surface would show these marks of smoothing.

The course of the striæ in Maine vary from north 70 deg. west to north 80 deg. east.

At the Lubec lead mines, a series of striæ were observed upon the side of a perpendicular wall, following the course of the wall around a corner. The course of the striæ ultimately varied at right angles from their original directions. At several places at the sea shore the striæ have been noticed below high water mark, and others were seen to run under the ocean at low-water mark. The course of the striæ upon the lakes north of the Katahdin mountains have more of an easterly course than those to the east and south of the same mountains. It looks as if the mountains formed an obstruction around which the striating agency operated, in preference to climbing the elevation. It is a curious fact, in the same connection, that the striæ are wanting on the summit of Katahdin. It appears also that there was another deflection of the course of the striæ in the valley of Sandy river. Mt. Abraham may have arrested the drift current on the north and turned it into Sandy river valley on the west, from which deflection it struck against the Saddleback mountain range, continued to Mount Blue, and was then directed toward French's Mountain in Farmington.

Drift striæ are never found upon the south side of mountains, unless for a short distance, where the slope is very small. It is common to see different courses of striæ intersecting one another, as on the south side of Chamberlin lake, where striæ north 70 deg. west and north 50 deg. west intersect, and north 17 deg. west and north 67 deg. west intersect.

The only examples of glacial markings discovered, in Maine, are on the St. John river, in its upper portion. Above the Lake of the Seven Islands, on this river, there are no glacial markings, unless the scratches upon the pavement of bowlders are to be referred to them. The bed of the river is full of stones, and upon the banks below high-water mark they are as firmly set as paving stones in the streets of a city. The scratches are not as constant and distinct as those of the glacier below, and may possibly have been formed by ice freshets in

the spring of the year. Descending the river to No. 14 we find a ledge which has been struck by a force descending the river, as the stoss and lee sides plainly show. The course of the striæ is north 65 deg. west, the stoss side being on the southeast. A similar example occurs near the mouth of Black river, where the course of the striæ is toward north 60 deg. west. The country above Black river being quite level, is not so well adapted for the existence of a glacier as the region below, where high mountains crowd the river on both sides. At the mouth of Little Black river the upper side of the ledges is uniformly the struck side. Some of the ledges are covered with both drift and glacial striæ, the former coming from north 60 deg. west, and the latter running down the river northeasterly. A mile above the mouth of the St. Francis river, the glacial striæ run down the river with the direction north 47 deg. east. Near the village of St. Francis the two sets of striæ appear again, the drift with the directions of north 60 deg. west, and north 20 deg. west, and the glacial with the direction of north 16 deg. east. This is the course of the river around a curve. The former are here the most prominent. In the township below Fort Kent, striæ appear running north 30 deg. west. One of the finest exposures of the glacial striæ is in Dionne, where the river makes a great bend and pursues a northerly course. The striæ change with the river and run north 20 deg. west, or directly opposite to the normal course of the drift in the vicinity, the force having gone northerly instead of southerly. No glacial markings were observed below this, in fact the glacial and drift markings could not be distinguished from each other below the Madawaska settlements. The evidence for an ancient glacier is not so strong on the St. John river as in the western part of New England. Some might contend that the immense ice freshets in the spring would be sufficient to explain all the phenomena. On the other hand, the objection to glaciers in northern Maine would be less than in Massachusetts, on account of the colder climate.

An unstratified mass of a stiff, dark, bluish clay, containing rounded and striated bowlders, and called bowlder clay, is found on the precipitous banks of rapid streams in narrow valleys. It underlies the finer sands and gravels of later periods, and always rests directly upon the solid rocks.

Modified drift occurs, in Maine, in the form of moraine terraces, horsebacks, sea beaches, sea bottoms, marine clays and terraces. Moraine terraces are generally accumulations of gravel, bowlders and sand,

often arranged in heaps and hollows, or conical and irregular elevations with corresponding depressions. A class of alluvial ridges found in great abundance in Maine are called horsebacks. Sea beaches and sea bottoms are found 150 feet higher than the ocean level, and containing littoral shells. Fossiliferous marine clays form almost a continuous belt, extending up the rivers to about this height above the ocean. Alluvial terraces are those banks of loose materials, generally unconsolidated, which skirt the sides of the valleys about rivers, ponds, and lakes, and rise above one another like the seats of an amphitheater.

Prof. Edward Hitchcock* collected about 300 measurements of the drift striæ found in the State of Vermont. The course varied from north 70 deg. east to north 80 deg. west. It seems to have been rare to find the striæ, at any two points, exactly agreeing in direction, though he divided the predominant courses into three divisions, viz: 1. From the northwest. 2. From the northeast. 3. From the north. The striæ differ in size from the finest scratch visible, up to a furrow a foot deep.

Prof. J. W. Dawson† described the Post-pliocene deposits at Murray bay, on the St. Lawrence river, 90 miles below Quebec, where they consist of the Leda clay and Saxicava sand. There are several terraces at this place, varying from 30 to 132 feet above the sea level, but the highest true shore-mark observed, is a narrow beach of rounded pebbles at the height of 326 feet. This beach appears to become a wide terrace further to the north, and also on the opposite side of the bay. It probably corresponds with the highest terrace observed by Sir W. E. Logan, at Bay St. Paul, and estimated by him at the height of 360 feet. The two principal terraces at Murray bay correspond nearly with two of the principal shore-levels at Montreal and in various parts of Canada, where two lines of old sea beaches occur at about 100 to 150 feet, and 300 to 350 feet above the sea, though there are others at different levels.

Dr. F. V. Hayden‡ sketched the geology of the country about the headwaters of the Missouri and Yellow Stone, and said that throughout the Wind river valley there is a series of beds of great thickness intermediate in their character between the true lignite beds and the White river Tertiary deposits. They extend from Willow

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* Rep. on the Geo. of Vermont, vol. i.

† Can. Nat. and Geol., vol. vi.

‡ Am. Jour. Sci, and Arts. 2d ser., vol. xxxi.

Springs on the North Platte westward toward the Sweet Water mountains, and near the divide between the North Platte and Wind river they reach a thickness of 400 feet. From this divide throughout the Wind river valley they occupy the greater portion of the country, and though inclining in the same direction with the older strata the beds do not dip more than from 1 to 5 deg. They differ from the other deposits in the great predominance of arenaceous sediments, and in the absence of vegetable remains, but they contain fragments of turtles and numerous fresh-water and land shells. The entire thickness of these deposits is estimated at from 1,500 to 2,000 feet.

The White River Tertiary beds extend southward along the Laramie mountains to Willow Springs, and up the North Platte to Box Elder creek, and beyond in small outliers, showing that much has been removed by erosion. From the source of Box Elder creek, they extend to the head of Bates Fork, and westward to the Medicine Bow mountains. These beds for the most part, hold a horizontal position, while those of the lignite age are much disturbed; moreover, their position shows that they are of much more recent origin. The White river Tertiary deposits are followed by the White river bone beds, which pass up into the Pliocene of Niobrara by a slight physical break, and the latter are lost in the yellow marl or Lacs deposits.

Meek and Hayden* made a vertical section of the Tertiary rocks of Nebraska, in ascending order as follows :

1. Wind river deposits, consisting of light gray and ash-colored sandstones, with more or less argillaceous layers. Thickness from 1,500 to 2,000 feet. Found in the Wind river valley and west of the Wind River mountains.

2. The White River Group, consisting of white and light drab clays, with some beds of sandstone and local layers of limestone. Thickness 1,000 feet or more. Found on the Bad Lands of White river ; under the Loup river beds, on Niobrara, and across the country to the Platte. Age of the Miocene.

3. Loup river beds, consisting of fine loose sand, with some layers of limestone. Thickness, 300 to 400 feet. Found on Loup fork of Platte river, and extending north to the Niobrara river, and south an unknown distance. Age of the Pliocene.

They described from the Wind River Group, in the Wind river valley, *Helix veterna*, and *H. spatiosa*, now *Macrocyclis spatiosa.*

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* Proc. Acad. Nat. Sci., vol. xii.

W. M. Gabb* described, from the Eocene at Claiborne, Alabama, *Phos belliliratus;* from Vicksburg, *Tellina euryterma;* from a brown, highly ferruginous sandstone at Caddo Peak, Texas, *Meretrix yoakumi, Perna texana;* from Houston county, Texas, *Protocardia gambrina;* and from South Carolina, *Ostrea mortoni.*

He described, from the Miocene of Virginia, *Voluta sinuosa;* from Santa Barbara, California, *Turbonilla aspera*, now *Bittium asperum, Modelia striata, Rocellaria antiqua, Sphenia bilirata, Venus rhysomia, Cardita monilicosta*, and *Morrisia horni.*

Prof. Leo. Lesquereux† described, from the Pliocene beds at Brandon, Vermont, *Carpolithes brandonanus, C. brandonanus*, var. *elongatus, C. brandonanus*, var. *obtusus, C. fissilis, C. grayanus, C. irregularis, Carya vermontana, C. verrucosa, Fagus hitchcocki, Apeibopsis gaudini, A. heeri, Aristolochia curvata, A. obscura, A. œningensis, Sapindus americanus, Carpolithes bursaeformis, Cinnamomum novœangliœ, Illicium lignitum, Drupa rhabdosperma, Nyssa complanata, N. lœvigata*, and *N. microcarpa.*

In 1862, Gabb and Horn‡ described, from the Eocene, near Charleston, South Carolina, *Eschara texta, Reptescharella carolinensis ;* from Claiborne, Alabama, *Eschara ovalis, Semieschara tubulata, Cellepora cycloris, C. inornata, Escharella micropora ;* from Vicksburg, Mississippi, *Reptocelleporaria glomerata.*

They described, from the Miocene of St. Mary's river, Maryland, *Eschara fragilissima ;* from Petersburg, Va., *Ennalipora quadrangularis;* from the Miocene, of New Jersey, *Cellepora urceolata, Membranipora sexpunctata, Reptoflustrella tubulata ;* from Santa Barbara, California, *Semitubigera tuba, Entalophora punctulata, Cellepora californiensis, C. bellerophon, Reptescharella heermanni, R. plana, Phidolopora labiata, Reptoporina enstomata, Reptescharellina disparilis, R. heermanni, R. cornuta, Siphonella multipora, Membranipora californica, Crisina serrata*, and *Lichenopora californica.*

T. A. Conrad§ described, from the Miocene of Virginia, *Surcula engonata, S. nodulifera, Drillia impressa, D. distans, D. arata, D. bella, D. eburnea, Mangelia virginiana, Pleiorytis ovato, Busycon carinatum, B. filosum, Tritia scalaris*, now *Buccinum scalare, Astyris reticulata, Dactylus eboreus*, now *Oliva eborea, Leiotrochus distans,*

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* Proc. Acad. Nat. Sci., vol. xii.
† Geol. Vermont, vol. ii.
‡ Jour. Acad. Nat. Sci., 2d ser., vol. v.
§ Proc. Acad. Nat. Sci., vol. xiii.

Pecten fraternus, *Busycon tritonis*, *Melampus longidens*, *Mactra medialis*, *Astarte bella*, *A. virginica*, *Lirophora athleta*, *Dione densata*, and *D. virginiana*; from Calvert cliffs, and St. Mary's county, Maryland, *Surcula rugata*, *Bulliopsis marylandica*, *B. ovata*, *Astyris communis*, *A. avara*, var. *granulifera*, and *Busycon alveatum*; from South Carolina, *Anomalocardia trigintinaria*; from North Carolina, *Dentalium carolinense*, *Pecten edgecomensis*, *Noetia carolinensis*, *Dactylus carolinensis*, now *Oliva carolinensis*, and *Siliquaria carolinensis*; from Cumberland county, New Jersey, *Turritella æquistriata*, *T. cumberlandia*, *Saxicava*, *myæformis*, *Carditamera aculeata*, and *Astarte distans*; from California, *Lyropecten crassicardo*; and from the Eocene, at Enterprise, Clark county, Mississippi, *Crassatella producta*.

Wm. Stimpson described, from the Post-pliocene at Cape Hope, on the southeast side of Hudson's bay, *Cardium dawsoni*.

Along Lake Temiscamang,* the Ottawa river and Riviere Rouge, north of the Ottawa, the furrows conform in a general way to the directions of the river-valleys, the limits of which appear to have guided the moving masses which produced the grooves. The direction of the grooves at a single locality is not only not uniform, but, on the contrary, they frequently cross each other. Measurements taken at 145 different places in Canada show that there is no uniformity in the direction of the striæ, but as in these cases they vary from S. 80° E. to S. 70° W.

Bowlders are found in great abundance in many places, especially in the valleys, where the bowlder formation has been extensively denuded by the action of the water, and its lighter materials swept away. On elevations, they are often seen resting upon the unstratified drift, which, in the adjacent depressions of the surface, is covered over by stratified sand and clay. They appear, in most instances, to have traveled southward, but there are exceptions to this general rule. Thus in the county of Rimonski, in the valley of the Neigette river, there are large bowlders of limestone, one of them 40 feet in diameter, belonging to the Gaspe series, which have been moved several miles northward or northeastward. Farther down the valley of the St. Lawrence, blocks of trachytic granite have been carried northeastward from the Table-topped mountain down the valley of the Magdalen. There are also instances of the northward transportation of bowlders in Nova Scotia.

The valleys of the St. Lawrence and the Richelieu, in Canada East, and a considerable portion of the region between the St. Lawrence and

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* Geo. of Canada, 1863.

the Ottawa, to the east of the meridian of Kingston, are occupied by stratified clays, which, unlike those of western Canada, contain abundance of marine shells, for the most part identical with species now living in the lower St. Lawrence and the gulf. The clays are in many cases overlaid by sands, occasionally interstratified with clay, which also contain marine remains. The two are regarded as forming parts of one formation, and as corresponding to the upper and lower divisions of the Champlain clay of Vermont. The lower division is called the Leda clay, and the upper the Saxicava sand. If a line be drawn from the outlet of Lake Champlain to Ottawa, and from the extremities of this, as a base, two others be carried to Quebec, there will be included a very level triangular area of about 9,000 square miles, for the greater part covered by the Champlain clays and sands. The plains on either side of the St. Lawrence below Quebec are occupied by the same formation, which is found at intervals as far down as Matanne; while on the north side it covers an extensive area in the valley of the Saguenay and around lake St. John and its tributaries. Clays belonging to the lower division are found at various levels from the surface of the sea to 600 feet above it, and in some cases they have been observed some feet below the sea-level. The river Rouge enters the Ottawa between hills of bare rock; but on its western side, in the fourth range of Grenville, a bank of clay 125 feet in thickness occurs, the summit of which is 405 feet above the sea. Again, not far east of this river, in the rear of Grenville, and in the front of Harrington, is an area of several hundred acres, underlaid by stratified blue clay, the surface of which is about 500 feet above the sea. Several similiar portions of clay occur in that vicinity. In Gaspe, at the head of Lake Matapedia, stratified clay occurs at the height of 480 feet, and near the outlet of the same lake, at the height of 530 feet above the sea. At Bay St. Paul, on the north side of the St. Lawrence, terraces occur at 130 and 360 feet above the sea. Marine fossils occur throughout the strata in which these terraces are worn, and still higher at 390 feet above the sea level. In the valley of the Saguenay, marine clays, generally overlaid by sand and gravel, are found almost everywhere between Ha-ha bay and the west side of Lake St. Johns; as well as between that bay and Chicontimi. Between Chicontimi and Ha-ha bay the clay is sometimes 600 feet in thickness. About a half mile below the falls of Bell Riviere, marine shells occur in the clay at 400 feet above the sea.

The Saxicava sand forms a belt on the north side of the St.

Lawrence, at the base of the Laurentide hills, from Ottawa to Cape Tourmente. It expands on the St. Maurice to a breadth of thirty miles. To the westward it covers much of the surface in the triangular area between the St. Lawrence and the Ottawa east of the meridian of Kingston. Marine shells occur in this sand in Nepean, at 410 feet above the sea ; in Kenyon, at 335 feet ; in Fitzroy, at 330 feet ; in Winchester, at 300 feet ; and at Pakenham mills, at 226 feet. South of the St. Lawrence these sands are found along the boundary of New York. From the east side of Missisquoi bay, a belt extends between the clay plains of the south shore of the St. Lawrence, which it partly overlies, and the more elevated region to the southeast, as far as Metis. At the Wallbridge Mills, in Stanbridge, marine shells occur at a height of 160 feet, and near Upton, on the Grand Trunk railway, at 300 feet above sea level.

In 1863, J. S. Newberry* described, from the Miocene of Bellingham bay, *Equisetum robustum*, *Sabal campbelli*, *Quercus coriacea*, *Q. flexuosa*, *Q. banksiæfolia;* from Birch bay, Washington Territory, *Taxodium occidentale*, *Smilax cyclophylla;* and from Bellingham bay *Quercus elliptica*, and *Populus flabellum*.

Remond† described, from the Pliocene near Kirkers Pass, *Cardium gabbi*, and *Ostrea bourgeoisi*.

In 1864, T. A. Conrad‡ described, from the Eocene of Dallas county, Alabama, *Turritella præcincta;* from Pamunkey river, Virginia, *Protocardia virginiana ;* and from 6 miles east of Washington, D.C. *Dosiniopsis meeki*.

He described, from the Miocene at Natural Well, Dauphin county, North Carolina, *Fasciolaria subtenta*, and *Lirosoma curvirostrum*.

The Miocene§ Strata,on the northern slope of the Monte Diablo Range, consists of heavy-bedded sandstones.

In crossing over the Santa Cruz Range from Santa Cruz, in a northerly direction to the Santa Clara Valley, before reaching the metamorphic, a mass of rocks is traversed, which is much broken and elevated, some of the ridges being fully 2,000 feet high. In rising on to this elevated ridge, however, we first pass over a belt of unaltered strata, which near the town lie nearly horizontal, and which appear to have escaped the action of the elevating forces, by which the main

* Bost. Jour. Nat. Hist., vol. vii.
† Proc. Cal. Acad. Sci.
‡ Pro. Acad. Nat. Sci., vol. xiv.
§ Geo. Sur. of California, 1865.

chain has been raised. There appears to be no doubt that these horizontal strata are the same ones which are tilted up in the mountains, and that they belong to the Miocene Tertiary. At about six miles from Santa Cruz are some singular examples of weathered sandstone, which are known as the "Ruins" or the "Ruined City." Here perpendicular tubes or chimneys of rock are found, from one to three feet in diameter, the sandstone appearing to have been hardened in concentric layers by the infiltration of ferruginous solutions, and this hardened portion has withstood the action of the elements, while the softer bands, and the interior columnar or cylindrical masses, have weathered away, leaving a pile of rocks behind, which, by some exertion of the imagination, can be construed into a resemblance to a ruined city, on a very small scale.

The whole region traversed by the trail from Pescadero to Searsville, as far as the metamorphic on the eastern edge of the range, is bituminous shale, of Miocene age, with occasional beds of interstratified sandstone, of which the dip is irregular, but not high.

Between Petaluma and the entrance of Tomales bay, patches of Miocene sandstone occur from 250 to 300 feet thick, resting unconformably upon altered strata. The rocks are soft, yellow sandstone, with large nodules of hard, blue calcareous sandstone, imbedded in them. Between the highest points near the head of Tomales bay and Punta Keyes, there are minor ridges of Miocene sandstone, having a low southwest dip.

The sandstones of the Santa Monica and Santa Susanna Ranges, are, in large part, of Miocene age. The ridges bounding the San Fernando valley on the southwest, are made up of light bituminous slates, dipping generally to the east or north east; they form rounded hills, bearing the marks of extensive erosion. A higher range to the west of these hills connects the two chains, and rises to a height of 3,000 feet above the sea, being made up of Miocene sandstones, highly inclined and in some places metamorphosed.

The chain of the Santa Inez Range rises to the north of Santa Barbara, a conspicuous object to those approaching this place by water. As far as known, it takes its origin at a point due north of Buenaventura, and running a little north of west (N. 84 deg. W.) for a distance of over 60 miles, it meets the sea at Point Concepcion. The chain has its greatest elevation apparently near Santa Barbara, where it is about 3,800 feet high. To the west of the Gaviota Pass it has an elevation of about 2,500 feet. The main ridge is entirely composed of Miocene

sandstones, without any appearance of eruptive rock, and also with very little metamorphism.

The unaltered sandstones extending along the Gavilian Range, near the San Juan valley, and forming the San Juan hills, which extend to the Pajaro river, are referred to the Miocene. In these hills the strata are very heavy bedded, and have a dip everywhere to the south. The materials of which they are made up are often coarse, and sometimes large enough to form a conglomerate, among the pebbles of which jasper and other metamorphic rocks predominate.

In the vicinity of the Bay of Monterey the granite is flanked by Miocene sandstone. Both rocks are considerably altered, for a distance of about 20 feet from the junction; the sandstone is softened and disintegrated, and the granite discolored. The metamorphism has so affected both rocks that it is not easy to determine the exact line of junction.

The Miocene sandstones are displayed in some places in the region between the Canada de las Uvas and Soledad Pass, nearly 2,500 feet in thickness. From the summit of the higher upturned strata, a wide belt of Tertiary rocks may be seen skirting the Coast Ranges, and worn into rounded hills, which are generally barren, especially on the west side of the Tulare valley.

The Pliocene beds between Merced Lake and Mussel Point, on the peninsula of San Francisco, are made up of a bluish sandstone, of which the grains are cemented by carbonate of lime, interstratified with hard, fine conglomerates, of which the pebbles are evidently derived from the adjacent jaspery rocks of Cretaceous age. These strata contain *Scutella interlineata*, *Crepidula princeps*, both of which are extinct, together with several species still living on the coast.

At the head of Pleasant valley, the strata are overlaid by beds of volcanic ashes, interstratified with gravels, the whole series being conformable and dipping at a low angle to the east. They appear to be of Pliocene age, and identical in most respects with the sedimentary volcanic beds to the north of Kirker's Pass.

To the north of San Pablo are low hills of very recent strata, which are nearly horizontal, and which rest unconformably on the edges of the Tertiary. They are referred to Post-pliocene age.

From Tres Pinos, 13 miles from San Juan, to Booker's, a distance of about 13 miles in a direct line, the road follows the Arroyo Joaquim Soto, a branch of the San Benito. Along this road there are vast deposits of gravel, or entirely unconsolidated detritus, and which form a

large portion of the series of ridges between the Gavilan, on the one side, and the Monte Diablo Range on the other. At the first exposure, about two miles beyond Tres Pinos, the stratified detritus forms a steep bluff about 400 feet above the creek. The gravel is made up of pebbles of granite, red and green jaspers, and silicious slate and other metamorphic materials. At a point a few miles below Bookers the strata are worn into precipitous canons, with bare bluff banks or almost perpendicular walls, regularly stratified, and varying in fineness from a coarse gravel to fine sand, with here and there a thin band of consolidated materials, the remainder entirely in the original condition in which it was deposited, as far as being held together by any cement is concerned. The thickness of these deposits is enormous; one hill was found to be 1,274 feet above the valley, and another 1,800 feet. Both these hills are entirely made up of these unconsolidated materials. This region gives one a most vivid idea of how recently geological changes of magnitude have taken place in this part of the State, and furnishes most impressive testimony to add to that obtained in other places, in relation to the lateness of the geological epoch, during which this portion of the chain was elevated. It would appear that the basin, in which these strata were deposited, was drained of the water at successive intervals, by the elevation of the basin itself, judging from the disturbed position of the strata it contains, and not by the gradual wearing away of a barrier at its lower end.

Prof. J. W. Dawson* described the Post-pliocene deposits in the country around Cacouna and Riviere-du-Loup. The depressions between the ridges are occupied by these deposits resting upon the Quebec Group of rocks. The oldest member of the deposit, is a tough marine bowlder clay, its cement formed of gray or reddish mud, derived from the waste of the shales of the Quebec Group, and the stones and bowlders with which it is filled, partly derived from the harder members of that Group, and partly from the Laurentian hills, on the opposite or northern side of the river, more than twenty miles distant. The thickness of the bowlder clay is variable, but at Ile Verte, it forms a terrace 50 feet in height. The bowlder clay at Cacouna, is a deep-water deposit. Its most abundant shells are *Leda truncata*, *Nucula tenuis*, and *Tellina proxima*, and these are imbedded in the clay with the valves closed, and in as perfect condition as if the animals still inhabited them. The bowlder clay is also fossiliferous at Murray bay, St. Nicholas, and Cape Elizabeth.

* Can. Nat. and Geol. new ser., vol. ii.

Above the bowlder clay, there occurs a dark gray, soft, sandy clay, containing numerous bowlders, and above this several feet of stratified sandy clay without bowlders ; while on the sides of the ridges, and at some places near the present shore, there are beds and terraces of sand and gravel constituting old shingle beaches, apparently much more recent than the other deposits. All of the deposits are more or less fossiliferous. The surface of the rocks beneath the bowlder clay, is polished and striated in the direction of northeast and southwest, or that of the St. Lawrence valley.

W. M. Gabb* described, from the Post-pliocene of San Pedro and Santa Barbara, *Turcica coffea*, and *Calliostoma tricolor*.

Dr. Joseph Leidy† described, from the Miocene of White river, Nebraska, *Rhinoceros occidentalis ;* from Texas, *R. meridianus ;* from Calaveras county, California, *R. hesperius*. And from the Pliocene of California, *Equus occidentalis*.

R. P. Whitfield‡ described, from the Eocene of the Southern States, *Pisania claibornensis*, *Pyrula juvenis*, *Fulgur triserialis*, *Fusus tortilis*, *Pseudoliva elliptica*, *Monoptygma leai*, *Columbella turricula*, *Pleurotoma capax*, *P. nasutum*, *P. persa*, *P. adeona*, *Voluta newcombana*, *Mitra haleana*, *M. biconica*, *Natica erecta*, now *Lacunaria erecta*, *N. perspecta*, *N. reversa*, *N. onusta*, *N. alabamensis*, now *Lacunaria alabamensis*, *N. aperta*, *Velutina expansa*, *Cerithium vinctum*, *Potamides alabamensis*, *Turritella eurynome*, *T. multilira*, *T. alabamensis*, *Cucullæa macrodonta*, *Crassatella tumidula*.

T. A. Conrad§ described, from the Jackson Group, at Enterprise, Mississippi, *Corbula filosa*, *Dione securiformis*, *D. annexa*, *Tellina eburneopsis*, *T. albaria*, *T. linifera*, *Alveinus minutus*, *Sphærella bulla*, *Cyclas curta*, *Protocardia lima*, *Gouldia pygmæa*, *Axinæa inequistriata*, *A. duplistriata*, *Nuculana linifera*, *Nucula spheniopsis*, *Arcoperna filosa*, *Pecten scintellatus*, now *Camptonectes scintellatus*, *Doliopsis quinquecosta*, now *Galeodia quinquecosta*, *Turritella perdita*, *Mesalia arenicola*.

From divers places in Alabama, Mississippi and Texas, *Strepsidura lintea*, *Surcula gabbi*, *S. lintea*, *Cochlespira engonata*, *Moniliopsis elaborata*, *Drillia texana*, *Tortoliva texana*, *Monoptygma curta*, *Volutilithes indenta*, *V. impressa*, *Obeliscus perexilis*, *Architectonica*

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* Pro. Cal. Acad. Sci.

† Pro. Acad. Nat. Sci.

‡ Am. Jour. Conch., vol. i.

§ Am. Jour. Conch., vol. i.

cœlatura, *Cancellaria impressa*, *C. tortiplica*, *Tornatellœa lata*, *Corbula filosa*, *Egeria donacea*, *Cytheriopsis hydana*, *Cyclas claibornensis*, *Mysia deltoidea*, *Conus alveatus*, *C. subsauridens*, *Cochlespira bella*, *Buccitriton altum*, *Limatia marylandica*, *Cirsostrema claibornensis*, *Cancellaria ellapsa*, *Dentalium densatum* ; from Shark river, Monmouth county, New Jersey, *Pleurotomaria perlata*, *Surcula annosa*, *Actœonema prisca*, and *Avicula annosa*.

In 1866, Prof. J. W. Dawson* said the snow-clad hills of Greenland send down to the sea great glaciers, which in the bays and fiords of that inhospitable region, form, at their extremities, huge cliffs of everlasting ice, and annually "calve," as the seamen say, or give off a great progeny of ice islands, which slowly drifted to the southward by the Arctic current, pass along the American coast, diffusing a cold and bleak atmosphere, until they melt in the warm waters of the Gulf stream. Many of these bergs enter the straits of Belle-Isle, for the Arctic current clings closely to the coast, and a part of it seems to be deflected into the Gulf of St. Lawrence through this passage, carrying with it many large bergs. Mr. Vaughan, late superintendent of the light house at Belle-Isle, has kept a register of icebergs for several years. He states that for ten which enter the straits, fifty drift to the southward, and that most of those which enter pass inward on the north side of the island, drift toward the western end of the straits and then pass out on the south of the island, so that the straits seem to be merely a sort of eddy in the course of the bergs. The number in the straits varies much in different seasons of the year. The greatest number are seen in spring, especially in May and June; and toward autumn and in the winter very few remain. Those which remain until autumn are reduced to mere skeletons; but if they survive until winter, they again grow in dimensions, owing to the accumulations upon them of snow and new ice. Those that we saw early in July were large and massive in their proportions. The few that remained when we returned in September, were smaller in size, and cut into fantastic and toppling pinnacles. Vaughan records that on the 30th of May, 1858, he counted in the straits of Belle-Isle 496 bergs, the least of them 60 feet in height, some of them half a mile long and 200 feet high. Only $\frac{1}{8}$ of the volume of floating ice appears above water, and many of these great bergs may thus touch the ground in a depth of 30 fathoms or more, so that if we imagine 400 of them moving up and down under the influence of

* Can. Nat. & Geol., 2d series, vol. iii.

the current, oscillating slowly with the motion of the sea, and grinding on the rocks and stone-covered bottom, at all depths, from the center of the channel, we may form some conception of the effects of these huge polishers of the sea floor.

Of the bergs which pass outside of the straits, many ground on the banks off Belle-Isle. Vaughan has seen a hundred large bergs aground at one time on the banks, and they ground on various parts of the banks of Newfoundland, and all along the coast of that island. As they are borne by the deep seated cold current, and are scarcely at all affected by the wind, they move somewhat uniformly, in a direction from N. E. to S. W., and when they touch the bottom the striation or grooving which they produce must be in that direction.

In passing through the straits in July, we saw a great number of bergs, some were low and flat topped with perpendicular sides, others were concave or roof-shaped like great tents pitched on the sea ; others were rounded in outline or rose into towers and pinnacles. Most of them were of a pure dead white, like loaf sugar, shaded with pale bluish green in the great rents and recent fractures. One of them seemed as if it had grounded and then overturned, presenting a flat and scored surface covered with sand and earthy matter.

After describing the glaciers of Mont Blanc, he lays down the following rules :

1. Glaciers heap up their debris in abrupt ridges. Floating ice sometimes does this, but more usually spreads its load in a more or less uniform sheet.

2. The material of moraines is all local, icebergs carry their deposits often to great distances from their sources.

3. The stones carried by glaciers are mostly angular, except where they have been acted on by torrents. Those moved by floating ice are more often rounded, being acted on by the waves and by the abrading action of sand drifted by currents.

4. In the marine glacial deposits, mud is mixed with stones and bowlders. In the case of land glaciers, most of this mud is carried off by streams, and deposited elsewhere.

5. The deposits from floating ice may contain marine shells. Those of glaciers can not, except where, as in Greenland and Spitzbergen, glaciers push their moraines out into the sea.

6. It is the nature of glaciers to flow in the deepest ravines they can find, and such ravines drain the ice of extensive areas of mountain land. Icebergs, on the contrary, act with greatest ease on flat surfaces, or slight elevations in the seat bottom.

7. Glaciers must descend slopes, and must be backed by large supplies of perennial snow. Icebergs act independently, and being water-borne, may work up slopes and on level surfaces.

8. Glaciers striate the sides and bottoms of their ravines very unequally, acting with great force and effect only on those places where their weight impinges most heavily. Icebergs, on the contrary, being carried by constant currents, and over comparatively flat surfaces, must striate and grind more regularly over large areas, and with less reference to local inequalities of surface.

9. The direction of the striæ and grooves produced by glaciers depends on the direction of the valleys. That of icebergs, on the contrary, depends upon the direction of marine currents, which is not determined by the outline of surface, but is influenced by the large and wide depressions of the sea bottom.

10. When subsidence of the land is in progress, floating ice may carry bowlders from lower to higher levels. Glaciers can not do this under any circumstances, though in their progress they may leave blocks perched on the tops of peaks and ridges.

He further said, that, in all these points of difference, the bowlder clay and drift of Canada, and other parts of North America, correspond rather with the action of floating ice than of land ice. More especially is this the case in the character of the striated surfaces, the bedded distribution of the deposits, the transport of material up the natural slope, the presence of marine shells, and the mechanical and chemical character of the bowlder clay.

He also enumerated the following Post-pliocene plants as occurring, in nodules, at Green's Creek, and other places in Canada, to-wit: *Drosera rotundifolia*, *Acer spicatum*, *Potentilla canadensis*, *Gaylussaccia resinosa*, *Populus balsamifera*, *Thuja occidentalis*, *Potamogeton perfoliatus*, *P. pusillus*, *Equisetum scirpoides*. None of the plants are properly Arctic in their distribution, and the assemblage may be characterized as a selection from the present Canadian flora of some of the more hardy species having the most northern range. At Green's Creek (near Ottawa) the plant-bearing nodules occur in the lower part of the Leda clay, which contains a few bowlders, and is apparently, in places, overlaid by large bowlders, while no distinct bowlder clay underlies it. The circumstances which accumulated the thick bed of bowlder clay near Montreal, were probably absent in the Ottawa valley. In any case, we must regard the deposits of Green's Creek as coeval with the Leda clay of Montreal, and with the period

of the greatest abundance of *Leda truncata*, the most exclusively Arctic shell of these deposits. In other words, he regarded the plants above mentioned as probably belonging to the period of greatest refrigeration of which we have any evidence—of course, not including that mythical period of universal incasement in ice, of which, in so far as Canada is concerned, there is no evidence whatever.

The Tertiary formation * exists in the southern part of the State of Illinois. It is best developed in Pulaski and Massac counties. It is represented by a series of stratified sands and clays of various colors, with beds of silicious gravel, often cemented into a ferruginous conglomerate by the infiltration of a hydroxyd of iron. In some places it contains green, marly sand, with casts of fossils, and along the edge of the Ohio, at extreme low water, at Caledonia, there is a thin bed of lignite. At Fort Massac, just above Metropolis, the ferruginous conglomerate is from forty to fifty feet in thickness. Near Caledonia, a section gave a thickness of 56½ feet.

T. A. Conrad† described, from the Miocene of the Eastern and Southern States, *Nassa subcylindrica*, *Volutifusus typus*, *Cancellaria scalarina*, *Saxicava parilis*, *Spisula capillaria*, *Tellina peracuta*, *T. capillifera*, *Astarte compsonema*, *Lithophaga subalveata*, *Macoma virginiana*, *Mercenaria obtusa*, and *Cumingia medialis*.

Philip P. Carpenter‡ described, from the Pliocene of Santa Barbara, California, *Turritella jewetti*, *Bittium armillatum*, *Opalia insculpta*, *Trophon tenuisculptus*, and *Pisania fortis*.

In 1867, Prof. E. W. Hilgard§ said that nowhere has the geologist more need of divesting himself of reliance upon lithological characters, than in the study of the Mississippi Eocene. Not only do the materials of the different groups often bear a most extraordinary resemblance to each other, but their character varies incessantly, *in one and the same stratum*, within short distances. Hale remarks that in Mississippi, the Orbitoides limestone seems to be represented by blue marlstone, and so it is, sometimes. But while on the one hand we see the hard limestone of the Vicksburg bluff passing into blue marl (Byram, Marshall's quarry), we on the other hand find it passing equally into a rock undistinguishable from that of St. Stephens (Brandon, Wayne county); the varied fossils described by Conrad disappearing almost

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* Geo. Sur. of Ill., vol. i.
† Am. Jour. Conch., vol. ii.
‡ Ann. & Mag. Nat. Hist., 3d ser., vol. xvii.
§ Am. Jour. Sci. & Arts, 2d ser., vol. xliii.

entirely, to be replaced by millions of Orbitoides imbedded in a semi-indurate mass of carbonate of lime, interspersed at times with similarly constituted conglomeratic masses of *Pecten poulsoni.* He could not, therefore, agree to the propriety of distinguishing as separate divisions the Orbitoides limestone, and the Vicksburg Group. The occurrence of a different species of Orbitoides (*O. nupera*) at Vicksburg, does not alter the case, for the undoubted *O. mantelli* occurs there also, in the solid rock. And there are few of the characteristic fossils of the Vicksburg profile, which do not, on some occasions, occur side by side with the *O. mantelli*, and its companions, *Pecten poulsoni*, and *Ostrea vicksburgensis.* Of course, the coral had its favorite haunts—the mollusks theirs. There is nothing surprising in the fact, that where one abounds, the others are usually scarce, or *vice versa.* He regarded the Shell Bluff Group of Conrad, or the Red Bluff Group—No. 4 of the Vicksburg section—which is characterized by the occurrence of *Ostrea georgiana*, as more or less co-extensive with the Vicksburg Group, and regularly associated with it, as a subordinate feature. Its inconsiderable thickness readily explains its entire absence at many points, where, stratigraphically, it ought to appear.

Prof. E. D. Cope* described, from the Miocene of Charles county, Maryland, *Eschrichtius cephalus*, *Rhabdosteus latiradix*, *Squalodon mento*, *Aetobatis profundus*, *Myliobatis gigas*, *M. pachyodon*, *M. vicomicanus*, *Raja dux*, *Notidanus plectrodon*, *Galeocerdo lævissimus*, *Sphyrna magna*, *Trionyx cellulosus*, *Thecachampsa contusor*, *T. sericodon*, *Orycterocetus crocodilinus*, *Priscodelphinus acutidens*, *Eschrichtius leptocentrus*, *Squalodon protervus*, and *Galera macrodon.*

T. A. Conrad† described, from the Eocene of Texas, *Venericardia mooreana;* from the Miocene of the Eastern and Southern States, *Pleuromeris decemcostata*, *Mactra contracta*, *M. virginiana*, *Lucina densata*, *Cardium emmonsi*, *Mercenaria percrassa*, *Mulinia parilis*, *Semele carolinensis*, *Abra nuculiformis*, *Corbula curta*, *Pecten tricarinatus*, *P. yorkensis*, *Sycotypus pyriformis*, *Cylichna*, *virginica*, *Zizyphinus briani*, *Z. punctatus*, *Neverita densata*, *N. emmonsi*, *Ptychosalpinx*, *scalaspira*, *Paranassa granifera*, *Bursa centrosa*, and *Busycon dumosum.* Prof. Gill described, from North Carolina, *Sycotypus elongatus.*

In 1868, Prof. J. W. Dawson‡ offered the following reasons, to show,

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* Proc. Acad. Nat. Sci.
† Am. Jour. Conch., vol. iii.
‡ Acadian Geology.

that the drift deposits of eastern America are not to be accounted for upon the theory of a terrestrial origin or a supposed glacial period.

1. It reqnires a series of suppositions unlikely in themselves, and not warranted by facts. The most important of these is the coincidence of a wide-spread continent, and a universal covering of ice in a temperate latitude. In the existing state of the world, it is well known that the ordinary conditions required by glaciers in temperate latitudes are elevated chains and peaks extending above the snow-line; and that cases, in which, in such latitudes, glaciers extend nearly to the sea level, occur only where the mean temperature is reduced by cold ocean currents approaching to high land, as for instance, in Terra del Fuego, and the southern extremity of South America. But the temperate regions of North America could not be covered with a permanent mantle of ice under the existing conditions of solar radiation; for, even if the whole were elevated into a table-land, its breadth would secure a sufficient summer heat to melt away the ice, except from high mountain peaks. Either, then, there must have been immense mountain-chains which have disappeared, or there must have been some unexampled astronomical cause of refrigeration, as, for example, the earth passing into a colder portion of space, or the amount of solar heat being diminished. But the former supposition has no warrant from geology, and astronomy affords no evidence for the latter view, which, beside, would imply a diminution of evaporation, militating as much against the glacier theory as would an excess of heat. An attempt has recently been made by Professor Frankland to account for such a state of things, by the supposition of a higher temperature of the sea, along with a colder temperature of the land; but this inversion of the usual state of things is unwarranted by the doctrine of secular cooling of the earth; it is contradicted by the fossils of the period, which show that the seas were colder than at present; and if it existed, it could not produce the effects required, unless a preter-natural arrest were at the same time laid on the winds, which spread the temperature of the sea over the land. The alleged facts observed in Norway, and stated to support this view, are evidently nothing but the results ordinarily observed in ranges of hills, one side of which fronts cold sea-water, and the other land warmed in summer by the sun.

The supposed effects of the varying eccentricity of the earth's orbit, so ably expounded by Mr. Croll, are no doubt deserving of consideration in this connection; but I agree with Sir Charles Lyell in regarding them as insufficient to produce any effect so great as that refrigera-

tion supposed by the theory now before us, even if aided by what Sir Charles truly regards as a more important cause of cold—namely, a different distribution of land and water, in such a manner as to give a great excess of land in high latitudes.

2. It seems physically impossible that a sheet of ice, such as that supposed, could move over an uneven surface, striating it in directions uniform over vast areas, and often different from the present inclinations of the surface. Glacier ice may move on very slight slopes, but it must follow these ; and the only result of the immense accumulation of ice supposed, would be to prevent motion altogether by the want of slope or the counter-action of opposing slopes, or to induce a slight and irregular motion toward the margins, or outward from the more prominent protuberances.

It is to be observed, also, that, as Hopkins has shown, it is only the sliding motion of glaciers that can polish or erode surfaces, and that any internal changes, resulting from the mere weight of a thick mass of ice resting on a level surface, could have little or no influence in this way.

3. The transport of bowlders to great distances, and the lodgment of them on hill-tops, could not have been occasioned by glaciers. These carry downward the blocks that fall on them from wasting cliffs. But the universal glacier supposed could have no such cliffs from which to collect ; and it must have carried bowlders for hundreds of miles, and left them on points as high as those they were taken from. On the Montreal Mountain, at a height of 600 feet above the sea, are huge bowlders of feldspar from the Laurentide Hills, which must have been carried 50 to 100 miles from points of scarcely greater elevation, and over a valley in which the striæ are in a direction nearly at right angles with that of the probable driftage of the bowlders. Quite as striking examples occur in many parts of the country. It is also to be observed that bowlders, often of large size, occur scattered through the marine stratified clays and sands containing sea-shells ; and whatever views may be entertained as to other bowlders, it can not be denied that these have been borne by floating ice. Nor is it true, as has been often affirmed, that the bowlder clay is destitute of marine fossils. At Isle Verte, Riviere du Loup, Murray Bay, and St. Nicholas on the St. Lawrence, and also at Cape Elizabeth, near Portland, there are tough stony clays of the nature of true "till," and in the lower part of the drift, which contain numerous marine shells of the usual Post-pliocene species.

4. The Post-pliocene deposits of Canada, in their fossil remains and general character, indicate a gradual elevation from a state of depression, which on the evidence of fossils must have extended to at least 500 feet, and on that of far-traveled bowlders to several times that amount; while there is nothing but the bowlder clay to represent the previous subsidence, and nothing whatever to represent the supposed previous ice-clad state of the land, except the scratches on the rock surfaces, which must have been caused by the same agency which deposited the bowlder clay.

5. The peat deposits, with fir roots, found below the bowlder clay in Cape Breton, the remains of plants and land snails in the marine clays of the Ottawa, and the shells of the St. Lawrence clays and sands, show that the sea at the period in question had nearly the temperature of the present Arctic currents of our coasts, and that the land was not covered with ice, but supported a vegetation similar to that of Labrador and the north shore of the St. Lawrence at present. This evidence refers not to the later period of the Mammoth and the Mastodon, when the re-elevation was perhaps nearly complete, but to the earlier period contemporaneous with, or immediately following the supposed glacier period. In my former papers on the Post-pliocene of the St. Lawrence, I have shown that the change of climate involved is not greater than that which may have been due to the subsidence of land, and to the change of the course of the Arctic current, actually proved by the deposits themselves.

It has long been known to geologists, that in northeastern America, two main directions of striation of rock surfaces occur, from northeast to southwest, and from northwest to southeast; and that locally the directions vary from these to north and south, and east and west. It would seem that the dominant direction in the valley of the St. Lawrence, along the high lands to the north of it, and across western New York, is northeast and southwest; and that there is another series of scratches running nearly at right angles to the former, across the neck of land between Georgian Bay and Lake Ontario, down the valley of the Ottawa, and across parts of the eastern townships, connecting with the prevalent south and southeast striation, which occurs in the valleys of the Connecticut and Lake Champlain, and elsewhere in New England, as well as in Nova Scotia and New Brunswick. What were the determining conditions of these two courses, and were they contemporaneous or distinct in time? The first point to be settled in answering these questions is the direction of the force which

caused the striæ. Now, I have no hesitation in asserting, from my own observations, as well as from those of others, that for the southwest striation the direction was *from the ocean toward the interior, against the slope of the St. Lawrence valley.* The crag-and-tail forms of all our isolated hills, and the direction of transport of bowlders carried from them, show that throughout Canada the movement was from northeast to southwest. This at once disposes of the glacier theory for the prevailing set of striæ; for we can not suppose a glacier moving from the Atlantic up into the interior. On the other hand, it is eminently favorable to the idea of ocean drift. A subsidence of America, such as would at present convert all the plains of Canada and New York and New England into sea, would determine the course of the Arctic current over this submerged land from northeast to southwest; and as the current would move *up a slope*, the ice which it bore would tend to ground, and to grind the bottom as it passed into shallower water; for it must be observed that the character of slope which enables a glacier to grind the surface may prevent ice borne by a current from doing so, and *vice versa.*

Now, we know that in the Post-pliocene period, eastern America was submerged, and, consequently, the striation at once comes into harmony with other geological facts. We have, of course, to suppose that the striation took place during submergence, and that the process was slow and gradual, beginning near the sea and at the lower levels, and carried upward to the higher ground in successive centuries, while the portions previously striated were covered with deposits swept down from the sinking land or dropped from melting ice.

The predominant southwest striation, and the cutting of the upper lakes, demand an outlet to the west for the Arctic current. But both during depression and elevation of the land, there must have been a time when this outlet was obstructed, and when the lower levels of New York, New England and Canada were still under water. Then the valley of the Ottawa, that of the Mohawk, and the low country between Lakes Ontario and Huron, and the valleys of Lake Champlain and the Connecticut, would be straits or arms of the sea, and the current, obstructed in its direct flow, would set principally along these, and act on the rocks in north and south and northwest and southeast directions. To this portion of the process, I would attribute the northwest and southeast striation. It is true, that this view does not account for the southeast striæ observed on some high peaks in New England; but it must be observed that even at the time of greatest depression, the Arc-

tic current would cling to the Northern land, or be thrown so rapidly to the west that its direct action might not reach such summits.

Nor would I exclude altogether the action of glaciers in eastern America, though I must dissent from any view which would assign to them the principal agency in our glacial phenomena. Under a condition of the continent in which only its higher peaks were above the water, the air would be so moist, and the temperature so low, that permanent ice may have clung about mountains in the temperate latitudes. The striation itself shows that there must have been extensive glaciers, as now, in the extreme Arctic regions. Yet I think, that most of the alleged instances must be founded on error, and that old sea-beaches have been mistaken for moraines. I have failed to find even in our higher mountains any distinct sign of glacier action, though the action of the ocean breakers is visible almost to their summits; and though I have observed in Canada and Nova Scotia many old sea-beaches, gravel-ridges, and lake-margins, I have seen nothing that could fairly be regarded as the work of glaciers. The so-called moraines, in so far as my observation extends, are more probably shingle beaches and bars, old coast-lines loaded with bowlders, trains of bowlders or "ozars." Most of them convey to my mind the impression of ice-action along a slowly subsiding coast, forming successive deposits of stones in the shallow water, and burying them in clay and smaller stones as the depth increased. These deposits were again modified during emergence, when the old ridges were sometimes bared by denudation, and new ones heaped up.

We now have, in all, exclusive of doubtful forms, about one hundred species of marine invertebrates, from the Post-pliocene clays of the St. Lawrence valley. All, except four or five species, belonging to the older or deep water part of the deposit, are known as living shells of the Arctic or boreal regions of the Atlantic. About half of the species are fossil in the Post-pliocene of Great Britain. The great majority are now living in the Gulf of St. Lawrence, and on the neighboring coasts; and more especially on the north side of the gulf and the coast of Labrador. In so far, then, as marine life is concerned, the modern period in this country is connected with that of the bowlder clay by an unbroken chain of animal existence. These deposits in Lower Canada afford no indications of the terrestrial fauna ; but the remains of *Elephas primigenius*, in beds of similar age in Upper Canada, show that during the period in question, great changes occurred among the animals of the land ; and we may hope to find similar evidences else-

where, especially in localities where, as on the Ottawa, the debris of land-plants and land-shells occur in the marine deposits.

The Eocene of New Jersey* is known as the Upper marl bed, and has a thickness of 37 feet. Fossils are abundant wherever marl pits have been opened, between Deal on the sea shore and Clementon in Camden county.

The Miocene is recognized by its fossils in many localities in New Jersey. It is not always conformable with the Eocene below, and its thickness is variable.

In 1868, Prof. E. D. Cope† described the Miocene deposit of the western shore of Maryland, as consisting of a dark, sandy clay, varying from a leaden to a blackish color, through which water does not penetrate. Its upper horizon may be traced along the high shores and cliffs of the Chesapeake by the line of trickling springs which follow its upper surface. A great bed of shells occurs at from fourteen to twenty-two feet below its upper horizon.

He described, *Cetophis heteroclitus*, *Ixacanthus cœlospondylus*, *Priscodelphinus spinosus*, now *Belosphys spinosus*, *P. atropius*, now *B. atropius*, *P. stenus*, now *B. stenus*, *Zarhachis flagellator*, *Delphinapterus ruschenbergeri*, now *Tretosphys ruschenbergeri*, *D. lacertosus*, now *T. lacertosus*, *D. gabbi*, now *T. gabbi*, *D. hawkinsi*, now *T. hawkinsi*, *D. tyrannus*, now *Eschrictius tyrannus*, *E. pusillus*, *Megaptera expansa*, now *E. expansus;* from the Eocene green sand of Monmouth county, New Jersey, *Palæophis halidanus*, and *P. littoralis*.

Isaac Lea described, from a Miocene deposit, six miles northeast of Camden, New Jersey, *Unio alatoides*, *U. carriosoides*, *U. humerosoides*, *U. nasutoides*, *U. radiatoides*, *U. subrotundoides*, *U. roanokoides*, *U. ligamentinoides*, *U. grandioides*, and *U. corpulentoides*.

Dr. Joseph Leidy described, from blue clay and sand beneath a bed of bitumen of Pliocene age, in Hardin county, Texas, *Megalonyx validus*, *Trucifelis fatalis*, and *Emys petrolei*; from Douglas Flat, Calaveras county, California, *Elotherium superbum;* from Martinez, *Equus pacificus*, the largest known fossil horse tooth; from Ashley river, South Carolina, *Hoplocetus obesus*; from Gibson county, Indiana, *Dicotyles nasutus*, found when digging a well between 30 and 40 feet below the surface; from the Miocene of the Bad Lands of White river, Dakota, *Leptictis haydeni*, *Ictops dakotensis;* from Half-moon Bay

* Geo. of N. Jersey, 1868.
† Proc. Acad. Nat. Sci.

California, *Delphinus occiduus;* from Washington county, Texas, *Anchippus texanus;* from the Bad Lands of Nebraska, *Lophiodon occidentale*, and from Shark river, Monmouth county, New Jersey, *Anchippodus riparius.*

T. A. Conrad* described, from the Miocene of the Atlantic coast, *Volutella oviformis*, *Prunum virginiana*, now *Marginella virginiana*, *Mercenaria cuneata*, *Caryatis plionema*, *Carditamera recta* ; and from Wyoming, *Goniobasis carteri.*

Prof. O. C. Marsh† described, from the Tertiary at Antelope station, on the Union Pacific Railroad, 450 miles west of Omaha, in Nebraska, *Equus parvulus,* now *Protohippus parvulus.*

The Tertiary underlies a wide central belt in West Tennessee, and was subdivided by Prof. Safford,‡ in 1869, in ascending order, into 1, Porters' Creek Group ; 2, Orange Sand ; 3, Bluff Lignite ; 4, Post-pliocene beds, on the Mississippi Bluff, consisting of Bluff gravel and Bluff loam ; and superficial gravel beds, in other parts of the State, consisting of ore-region gravel, eastern gravel, and lastly of bottoms, and alluvial beds.

The Bluff lignite consists, especially in the middle and southern parts of the State, of a series of stratified sands, with more or less sandy, slaty clay, characterized by the presence of well-marked beds of lignite; though, in the northern part of the State, its upper portion is frequently more or less indurated, presenting layers of soft sandstone with less lignite. The upper part of the series is generally well exposed below the gravel of the Mississippi Bluffs. At Memphis, however, it scarcely appears above low-water. About one hundred feet of the series has been seen. In this thickness it contains from one to three beds of lignite, which are from half a foot to four feet in thickness.

The outcrop of the Orange sand or Lagrange Group, forms more than a third of the entire surface of West Tennessee. It occupies a belt, about 40 miles wide, which runs in a northeasterly direction, through nearly the central portion of this division of the State. As seen in bluffs, railroad cuts, gullies, and in nearly all exposures, it is generally a great stratified mass of yellow, orange, red or brown, and white sands, presenting occasionally an interstratified bed of white,

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* Am. Jour. Conch., vol. iv.

† Am. Jour. Sci. & Arts, 2d series, vol. xlvi.

‡ Geo. of Tenn.

grey, or variegated clay. The sand beds are usually more or less argillaceous ; sometimes but little, or not at all so. Like the Ripley Group, it contains, occasionally, patches, plates, and thin layers of ferruginous, sometimes argillaceous sandstone, and as in that group, presents, locally, massive blocks of sandstone on high points. At La Grange, a fine section of the group, more than a hundred feet in thickness, is exposed. It includes within its outcrop, nearly all of Fayette, Haywood, Madison, Gibson, and Weakley counties ; the larger parts of Hardeman, Carroll, and Henry ; and small parts of Shelby, Tipton, Henderson, Dyer, and Obion. He supposed this group to be of Eocene age, and to have a thickness of about 600 feet. This group must not be confounded with the Post-pliocene Orange sand of Hilgard, which occurs in Mississippi and Louisiana.

The Porter's Creek Group contains proportionally more laminated or slaty clay than the Orange Sand or Lagrange Group. Along the Memphis and Charleston railroad, the belt of surface occupied by the group is about eight miles wide. It becomes narrower in its northward extension, and appears to be the northern extension of the lower part of Hilgard's Northern Lignitic Group. The thickness is from 200 to 300 feet, and in this are usually several beds of slaty clay from five to fifty feet in thickness. It is well exposed on Porter's creek, in Hardeman county, and on the road from Bolivar to Purdy, commencing about seven miles from the former place, and extending to or beyond Wade's creek.

Prof. E. W. Hilgard* described the Grand Gulf Group, Orange Sand and Loess at Port Hudson, Miss., and gave a descending section midway between Port Hudson and Fontania as follows: 1st, Yellow loam, sandy below, 8 to 10 feet. 2d, White and yellow hard pan, 18 feet. 3d, Orange and yellow sand, sometimes ferruginous sandstone, irregularly stratified, 8 to 15 feet. 4th, Heavy, greenish or bluish clay, 7 feet. 5th, White, indurate silt or hard pan, 18 feet. 6th, Heavy, green clay, with porous, calcareous concretions above, ferruginous ones below; some sticks and impressions of leaves, 30 feet. 7th, Brown muck and white or blue clay with cypress stumps, 3 to 4 feet.

At the stage of extreme low water the stump stratum is visible to the thickness of 10 feet at its highest point; showing several generations of stumps, one above another, also the remnants of many successive falls of leaves and overflows. The wood is in a good state of

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* Am. Jour. Sci. & Arts, 2d series, vol. xlvii.

preservation. The stump stratum exists, at about the same level, over all the Delta plain of the Mississippi and along the Gulf coast from Mobile, on the east, to the Sabine river.

Dr. Joseph Leidy* described, from the White River Group of Dakota, *Oreodon affinis*, *O. bullatus*, *O. hybridus*, *Leptauchenia nitida*, *Homocamelus caninus*, *Cosoryx furcatus*, *Nanohyus porcinus*, *Protohippus placidus*, *Hipparion affine*, and *H. gratum*. He described from the Eocene near Fort Bridger, Wyoming,† *Omomys carteri*, *Trionyx guttatus*, *Emys wyomingensis*, and from South Bitter creek, near where it crosses the stage route, 70 miles west of the summit of the Rocky mountains, in western Wyoming, *Crocodilus aptus*.

Prof. E. D. Cope‡ described, from the Miocene of Shiloh, Cumberland county, New Jersey, *Tretosphys uræus*, *Zarhachis velox*, and *Trionyx lima*; from the mouth of the Patuxent river, Maryland, *Zarhachis tysoni*.

He described,§ from the Eocene marl pits, at Shark river, Monmouth county, N. J., *Hemicaulodon effodiens;* from Farmingdale, *Myliobates glottoides*, and *Cœlorhynchus acus;* from the Green River Group, on the upper waters of Green river, Wyoming, *Asineops squamifrons*, *Clupea pusilla*, *Cyprinodon levatus;* from the Miocene in Wayne county, North Carolina, *Pneumatosteus nahunticus;* from Duplin county, *Pristis attenuatus;* from Edgecombe county, *Eschrichtius polyporus;* from Quanky creek, Halifax county, *Mesoteras kerranus;* from Stafford county, Va., *Thinotherium annulatum*.

He described, from the Post-pliocene, at Savannah, Georgia, *Anoplonassa forcipata;* from cave Breccia, in Wythe county, Virginia, *Tamias lævidens*, *Sciurus panolius*, and *Galera perdicida*.

Prof. O. C. Marsh‖ described, from the Eocene, near Shark river, Monmouth county, New Jersey, *Dinophis grandis*.

T. A. Conrad¶ described, from the same locality, *Pecten kneiskerni*, *Crassatella littoralis*, *Crassina veta*, *Bucardia veta*, *Caryatis delawarensis*, *Protocardia curta*, *Onustus annosus*, and *Terebratula glossa*. And from the Miocene of St. Charles county, Maryland, and from Petersburg, Va., *Pecten cerinus*, *Callista virginiana*, *Saxicava insita*, *Scapharca tenuicardo*, *Mercenaria plena*, and *Capsa parilis*.

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* Jour. Acad. Nat. Sci., vol. vii.
† Proc. Acad. Nat. Sci.
‡ Proc. Acad. Nat. Sci.
§ Proc. Am. Phil. Soc., vol. xi.
‖ Am. Jour. Sci. & Arts, 2d series, vol. xlviii.
¶ Am. Jour. Conchology, vol. v.

W. M. Gabb* described, from the Miocene in Contra Costa county, near Tomales bay, near Martinez, Walnut creek, Monterey county, San Emidio, Cerros island, and other places in California, *Dosinia mathewsoni*, *Pecten packhami*, *Triptera clavata*, *Trophon ponderosum*, *Neptunea recurva*, *Metula remondi*, *Agasoma gravida*, *A. sinuata*, *Ranella mathewsoni*, now *Bursa mathewsoni*, *Cuma biplicata*, *Ancillaria fishi*, *Neverita callosa*, *Cancellaria vetusta*, *Turritella hoffmanni*, *Trochita filosa*, *T. inornata*, *Pachypoma biangulata*, *Pandora scapha*, *Hemimactra lenticularis*, *H. occidentalis*, *Schizodesma abscissa*, *Chione mathewsoni*, now *Callista mathewsoni*, *C. whitneyi*, now *C. whitneyi*, *Callista voyi*, *Dosinia conradi*, *Tapes truncata*, *Cardium meekanum*, *Conchocele disjuncta*, *Mytilus mathewsoni*, *Modiola multiradiata*, now *Volsella multiradiata*, *Pecten cerrocensis*, *P. veatchi*, *Ostrea atwoodi*, *O. taylorana*, *O. veatchi*, *O. cerrocensis*, *Asterias remondi*, *Ficus pyriformis*, *F. nodiferus*, *Venus pertenuis*. From the fresh water Tertiary, or Pliocene, on Snake river, in Idaho Territory, *Melania taylori*, and *Lithasia antiqua*; from the Pliocene, near Santa Barbara, Humboldt bay, San Francisco county, Kirker's Pass, Sonoma county, and other places in California, *Cancer breweri*, *Surcula carpenterana*, *Pleurosoma voyi*, *Columbella richthofeni*, *Littorina remondi*, *Zirphæa dentata*, *Gari alata*, *Dosinia staleyi*, now *Tapes staleyi*, *Cyrena californica*, *Lucina richthofeni*, *Neptunea altispira*, *N. humerosa*, *Sigaretus planicostum*, *Cancellaria altispira*, *Acmæa rudis*, *Siliquaria edentula*, *Caryatis barbarensis*, *Saxidomus gibbosus*. And from the Post-pliocene, near Santa Barbara, and San Pedro, *Surcula tryonana*, *S. perversa*, *Clathurella conradana*, *Muricidea paucivaricata*, *Trophon squamulifer*, *Cancellaria gracilior*, and *C. tritonidea*.

Prof. Leo. Lesquereux† described, from the Lower Eocene or Northern Lignitic Group of Tippah, Miss., and La Grange, and Sommerville, Tennessee, *Calamopsis danai*, *Sabal grayana*, now *Sabalites grayanus*, *Salisburia binervata*, *Populus monodon*, *Salix wortheni*, *S. tabellaris*, *Quercus moori*, *Q. retracta*, *Celtis brevifolia*, *Ficus schimperi*, *F. cinnamomoides*, *Laurus pedatus*, *Cinnamomum mississippiense*, *Persea lancifolia*, *Ceanothus meigsi*, *Juglans appressa*, *J. saffordana*, *Magnolia laurifolia*, *M. lesleyana*, *M. ovalis*, *M. cordifolia*, *Asimina leiocarpa*, and *Phyllites truncatus*.

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* Pal. of Cal., vol. ii.

† Trans. Am. Phil. Soc., vol. xiii.

Oswald Heer* described, from the Tertiary of Alaska, *Pteris sitkensis, Taxodium tinajorum, Taxites microphyllus, Phragmites alaskanus, Poacites tenuistriatus, Carex servata, Sagittaria pulchella, Vaccinium friesi, Diospyros stenosepala, Viburnum nordenskioldi, Hedera auriculata, Vitis crenata, Tilia alaskana, celastrus borealis, Ilex insignis, Trapa borealis, Juglans nigella, J. picroides, Spiræa andersoni*, and identified numerous plants with those described from the Miocene of Europe. He described the insect *Chrysomelites alaskanus*, and Dr. Carolus Mayer described, *Unio onariotis, U. athlios, Paludina abavia*, and *Melania furuhjelmi.*

The Jackson Group, in Louisiana,† consists of marine strata; of lignitic beds that tell of swamps; and of nonfossiliferous beds of laminated sands and clays. It spreads over the State north of the Vicksburg outcrop and west of the Bastrop Hills. The marine strata contain massive clays, often full of selenite. At Grand View there is a stratum of such clay 85 feet thick.

The Vicksburg Group, in Louisiana, consists of smooth, yellow and red clays, with a very small proportion of sand. Limestone nodules occur, generally, soft and yellow, but sometimes hard and white, and always full of casts of shells. It is exposed from Godwin's shoals to about six miles south of Natchitoches, and from a point below Montgomery to the Washita, below Grand View, but it never occupies an area more than about twelve miles wide.

In 1870, Dr. Joseph Leidy‡ described, from the Fort Bridger Eocene, of Wyoming, *Baptemys wyomingensis*, now *Dermatemys wyomingensis, Emys stevensonanus, Patriofelis ulta, Lophiodon modestus, Hyopsodus paulus, Emys jeansi, E. haydeni, Baena arenosa, Saniva ensidens;* from near the junction of the Big Sandy and Green rivers, *Palæosyops paludosus, Crocodilus elliotti;* from Black's Fork, *Microsus cuspidatus, Notharctus tenebrosus;* from the Tertiary of Colorado, *Megacerops coloradoensis;* from the Tertiary of the Rocky mountain region, *Oncobatis pentagonus, Mylocyprinus robustus;* from Henry's Fork of Green river, *Lophiotherium sylvaticum;* from the Miocene in the valley of Bridge creek, a tributary of John Day's river, Oregon, *Oreodon superbus, Anchitherium condoni;* from Gay Head, Martha's Vineyard, *Graphiodon vinearius;* from the

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* Flora Fossilis Alaskana.
† Geo. of Louisiana, 1870.
‡ Proc. Acad. Nat. Sci.

Pliocene of the Niobrara river, *Merychochœrus rusticus ;* from Dry creek, Stanislaus county, California, *Mastodon shepardi ;* and from Tuolumne county, *Auchenia californica.*

Prof. O. C. Marsh* described, from the Eocene of New Jersey, *Thecachampsa minor;* from the Miocene of Edgecombe county, North Carolina,† *Catarractes antiquus;* from Maryland, *Puffinus conradi;* from the Niobrara river, *Grus haydeni, Graculus idahensis;* from Squankum, New Jersey,‡ *Rhinoceros matutinus;* from Shark river, *Dicotyles antiquus;* and from the Pliocene at Monmouth, *Meleagris altus.*

Prof. F. B. Meek described, from the Miocene, at Fossil Hill, Hot Spring mountains, Idaho, *Sphœrium rugosum, S. idahoense, Ancylus undulatus, Goniobasis sculptilis, G. subsculptilis, Carinifex binneyi, C. concava* and *C. tryoni.*

T. A. Conrad§ described, from the Miocene of Virginia and South Carolina, *Artena undulata, Crepidula rostrata, C. recurvirostra, C. virginica, Persicula ovula,* and *Axinœa bella.*

The Grand Gulf Group of Louisiana‖ consists of nonfossiliferous clays and sandstones pretty regularly stratified, varied, occasionally, by clayey sand and beds containing twigs and leaves. The sandstone occurs in ledges from six inches to 20 feet in thickness. It is cut into four parts by the bluff and the alluvion of Red river and the Mississippi. One reaches the Vicksburg area and extends into Mississippi; another is southwest of Red river and extends into Texas; another is northeast of Red river as far as Sicily Island on the Ouachita; and the other is at the western part of the Avoyelles prairies.

In 1871, T. A. Conrad¶ described, from the Eocene at Claiborne, Alabama, *Caryatis exigua;* and from the Oligocene at Vicksburg, Mississippi, *Macoma sublintea,* and *Abra protexta.*

F. B. Meek** described, from the Bridger Eocene at Henry's Fork, Black's Fork, and Church buttes, Wyoming, *Viviparus wyomingensis.*

Brady and Crosskey†† described, from the Post-pliocene of Portland and Saco, Maine, and from Montreal, Canada, *Cythere macchesneyi, C. logani, C. cuspidata, Cytherura cristata, C. granulosa,* and *Cytheropteron complanatum.*

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* Am. Jour. Sci. and Arts, 2d series, vol. 50.
† *Ibid*, vol. xlix.
‡ Proc. Acad. Nat. Sci.
§ Am. Jour. Conch., vol. vi.
‖ Geo. of Lou., 1871.
¶ Am. Jour. Conch., vol. vi.
** Proc. Acad. Nat. Sci.
†† Lond. Geo. Mag., vol. viii.

Dr. Joseph Leidy* described, from the Bridger Eocene of Wyoming, *Anosteira ornata*, *Hybemys arenarius*, *Testudo corsoni*, *Emys carteri*, *Baena undata*, *Trogosus vetulus*, now *Anchippodus vetulus*, *Sinopa rapax*, *Palæosyops major*, *Hyrachyus eximius*, *Paramys delicatus*, *P. delicatior*, and *P. delicatissimus*, all now *Plesiarctomys*, and *Mysops minimus.* He described from the Miocene of Alkali flats, Oregon, *Rhinoceras pacificus*, and from Crooked river, *Stylemys oregonensis*, now *Testudo oregonensis.*

Prof. E. D. Cope† described, from the Post-pliocene occurring in a limestone fissure in Chester county, Pennsylvania, *Megalonyx loxodon*, *M. sphenodon*, *M. tortulus*, *M. wheatleyi*, *Sciurus calycinus*, *Arvicola speothen*, *A. tetradelta*, *A. didelta*, *A. involuta*, *A. sigmodus*, *A. hiatidens*, *Erithizon cloacinum*, and *Praotherium palatinum.* He described from the Miocene near Tuxtla, Chiapas, Mexico, *Prymnetes longiventer.*

Prof. O. C. Marsh‡ described, from the Green river basin west of the Rocky Mountains, *Boavus agilis*, *B. brevis*, and *B. occidentalis;* from the Bridger Eocene of Wyoming, *Limnophis crassus*, *Lithophis sargenti*, *Crocodilus affinis*, *C. brevicollis*, *C. grinnelli*, *C. liodon*, *C. ziphodon*, now *Limnosaurus ziphodon*, *Glyptosaurus anceps*, *G. nodosus*, *G. ocellatus*, *G. sylvestris*, *Titanotherium* (?) *anceps*, *Lophiodon affinis*, *L. bairdianus*, *L. nanus*, *L. pumilis*, *Anchitherium gracile*, now (?) *Orohippus gracilis*, *Lophiotherium ballardi*, *Elotherium lentum*, *Platygonus ziegleri*, *Hyopsodus gracilis*, *Limnotherium elegans*, *L. tyrannus*, *Sciuravus nitidus*, *S. parvidens*, *S. undans*, *Triacodon fallax*, *Canis montanus*, *Vulpavus palustris*, and *Bubo leptosteus.*

He described from the Miocene at Scott's Bluff, on North Platte river, Nebraska, *Amphicyon angustidens;* from Northern Colorado, *Meleagris antiquus;* from Cumberland county, New Jersey,§ *Lophiodon validus*, now *Tapiravus validus;* and named, but did not describe, from Wyoming, *Amia depressa*, *A. newberryana*, *Lepidosteus glaber*, and *L. whitneyi.* Also from the Pliocene sands, near the headwaters of the Loup Fork river, Nebraska, (‖) *Platygonus striatus*, *Arctomys vetus*, *Geomys bisulcatus*, *Aquila dananus;* and from Oregon, *Platygonus condoni*, and *Dicotyles hesperius.*

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* Proc. Acad. Nat. Sci.
† Proc. Am. Phil. Soc., vol. xii.
‡ Am. Jour. Sci. and Arts, 3d series, vol. i. & ii.
§ Proc. Acad. Nat. Sci.
(‖) Am. Jour. Sci. and Arts, 3d series, vol. ii.

In 1872, Dr. Dawson* said, that the Bowlder clay of Canada consists of hard, gray clay, filled with stones, and thickly packed with bowlders, and usually rests directly on striated rock surfaces ; though in Cape Breton, a peaty or brown coal deposit, with branches of trees, has been found to underlie it, and in some places there are deposits of rolled gravel beneath it. The stones are often scratched and ground into wedge-shapes, as if by the action of ice. At Isle Verte, Riviere du Loup, Murray Bay, Quebec, and St. Nicholas, on the St. Lawrence it is fossilferous, containing, *Leda truncata*, *Balanus hameri*, and *Bryozoa.*

In some localities the stones in the Bowlder clay, are almost exclusively those of the neighboring rock formations, in others those having traveled from a distance predominate ; occasional instances occur where bowlders have been transported to the northward. Though the Bowlder clay often presents a somewhat widely extended and uniform sheet, yet it may be stated to fill up small valleys or depressions, and to be thin or absent on ridges and rising grounds.

Beneath the Bowlder clay on the St. Lawrence and the Ottawa, there are two sets of striæ, a southeast set, and a southwest set. In Nova Scotia and New Brunswick, as in New England, the prevailing direction is southeastward, though there are also southwest and south striation, and a few cases where the direction is nearly east and west. At the Mile end quarries, near Montreal, the polished and grooved surface of the limestone, shows four sets of striæ. The principal ones have the direction of S. 68° W. and S. 60° W. respectively, and the second of these sets is the stronger and coarser, and sometimes obliterates the first. The two other sets are comparatively few and feeble striæ, one set running nearly north and south, and the other northwest and southeast. These last are probably newer than the first two sets. The locality is to the northeast of the mass of trap constituting the Montreal mountain, and evinces that the movement must have been up the St. Lawrence, which is the dominant direction of the striæ in this valley. It is the Bowlder clay connected with this S. W. striation, that is rich in marine fossils.

At the mouth of the Saguenay, near Moulin Bode, are striæ and grooves on a magnificent scale, some of the latter being ten feet wide, and four feet deep, cut into hard gneiss. Their course is N. 10° W. to N. 20° W. magnetic, or N. 30° to 40° W. when referred to the true

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* Post-pliocene Geol.

meridian. In the same region, on hills 300 feet high, are roches moutonnees with their smoothest faces pointing in the same direction, or to the northwest. This direction is that of the valley or gorge of the Saguenay, which enters nearly at right angles the valley of the St. Lawrence.

In like manner at Murray Bay, there are striæ on the Silurian limestones near Point au Pique, which run about N. 45° W., but these are crossed by another set having a course S. 30° W., so that we have two sets of markings, the one pointing upward along the deep valley of Murray Bay river to the Laurentide hills inland, the other following the general trend of the St. Lawrence valley. The Bowlder clay which rests on these striated surfaces, is a dark-colored till, full of Laurentian bowlders, and holding *Leda truncata*, and also Bryozoa clinging to some of the bowlders. In ascending the Murray Bay river, we find these bowlder beds surmounted by very thick, stratified clays, with marine shells, which extend upward to an elevation of about 800 feet, when they give place to loose bowlders and unstratified drift.

The Bowlder clay over a large portion of the plain of Lower Canada is succeeded by the Leda clay, which varies in thickness from a few feet to 50 or perhaps 100 feet. The material of the Leda clay is of the same nature as the finer portion of the paste of the Bowlder clay, and the latter seems to graduate into the former. It sometimes holds hard, calcareous concretions, which, as at Green's creek, on the Ottawa, are occasionally richly fossiliferous. When dried, the Leda clay becomes of stony hardness, and when burned, it assumes a brick red color. When dried and levigated, it nearly always affords some foraminifera and shells of ostracoids; and in this, as well as in its color and texture, it closely resembles the blue mud now in process of deposition in the deeper parts of the Gulf of St. Lawrence. It extends west to where the Laurentian ridge of the Thousand Islands crosses the St. Lawrence, and where the same rocks cross the Ottawa, and in general may be said to be limited to the Lower Silurian plain, and not to mount up the Laurentian and metamorphic hills bounding it.

The Saxicava sand sometimes rests upon the Leda clay, sometimes upon Bowlder clay, and often on the older rocks. In some instances the surface of the Leda clay has been denuded and cut into deep trenches, and the sand rests abruptly upon it; in other cases there is a transition from one deposit to the other, the clay becoming sandy and gradually passing upward into pure sand. It must have been originally a marginal and bank deposit, depending much for its distribution

on the movement of tides and currents. In some instances, as at Cote des Neiges, near Montreal, and on the terraces on the Lower St. Lawrence, it is obviously merely a shore sand and gravel, like that of the modern beach.

The terraces and inland sea cliffs have been formed by the same recession of the sea which produced the Saxicava sand. At Montreal, where the isolated mass of trap, flanked with Lower Silurian beds, constituting Mount Royal, forms a great tide-gauge for the recession of the Post-pliocene sea, there are four principal sea margins, with several others less distinctly marked. The lowest of these, at a level of 120 feet above the sea, corresponds, in general, with the level of the great plain of Leda clay in this part of Canada. On this terrace, in many places, the Saxicava sand forms the surface, and the Leda clay and Bowlder clay may be seen beneath it. Another at 220 feet in height furnishes Saxicava sand resting on Bowlder clay. Three other terraces occur at heights of 386, 440 and 470 feet, and the latter has, at one place, above the village of Cote des Neiges, a beach of sand and gravel, with *Saxicava* and other shells. Even on the top of the mountain, at a height of about 700 feet, large traveled Laurentian bowlders occur.

The prevalent Post-pliocene deposit on Prince Edward Island is a Bowlder clay, or in some places bowlder loam, composed of red sandstones. This is filled with more or less rounded and striated bowlders of red sandstone, derived from the harder beds of the island. At Campbellton, however, in the western part of the island, a bed of Bowlder clay is found filled with bowlders of metamorphic rocks, similar to those of the mainland of New Brunswick. Striæ on the northeastern coast of the island have a direction S.W. and N.E. ; and on the southwestern coast S. 70° E.

At Campbellton, in the sand and gravel above the Bowlder clay, *Tellina greenlandica* occurs, at an elevation of about 50 feet above the sea. On the surface of the country, there are numerous traveled bowlders. Those of granite, syenite, diorite, felsite, porphry, quartzite and coarse slates are identical, in mineral character, with those which occur in the metamorphic districts of Nova Scotia and New Brunswick, at distances from 50 to 200 miles to the south and southwest; though some of them may have been derived from Cape Breton on the East. Those of gneiss, hornblende schist, anorthosite and labradorite rock must have been derived from the Laurentian rocks of Labrador and Canada, distant 250 miles or more to the northward.

In Nova Scotia and New Brunswick the Bowlder clay or unstratified drift varies from a stiff clay to loose sand, and its composition and color generally depend upon those of the underlying and neighboring rocks. Thus over sandstone it is arenaceous; over shales, argillaceous; and over conglomerates and hard slates, pebbly or shingly. The greater part of the stones contained in the drift are, like the paste containing them, derived from the neighboring formations; though, in some instances, they have been transported from a distance. The transported bowlders have generally been drifted southward, though some have been carried northward, and others in different directions. They have especially been drifted from the more elevated and rocky districts to the lower grounds in their vicinity. The striæ upon the rocks vary from north and south to east and west, though there is a general tendency to a southern and southeastern course.

Alfred R. C. Selwyn* found many fine examples of ice-grooves and scratches on the rocky shores of Vancouver's Island, where they occur in different directions, and sometimes nearly at right angles to each other. He quoted, with approval, the statement of Prof. J. D. Whitney, that northern drift does not occur in California, and that no evidence of its occurrence has yet been detected on the Pacific coast, as far north as British Columbia and Alaska. This conclusion having been arrived at on the authority of Mr. W. D. Dall, naturalist, attached to the Collin's Overland Telegraph Company, and who states that though he had carefully examined the country over which he had passed, in Alaska, for glacial indications, he had not found any effects attributable to such agencies; and that no bowlders, no scratches, or other marks of ice action had been observed by any of his party, though carefully sought for. And that inland, neither Mr. Selwyn nor his assistant Mr. Richardson observed any.

That the superficial deposits of British Columbia are chiefly developed in the ancient terraces or benches, which, throughout the country, are wonderfully regular and persistent, occuring from the coast up to elevations of nearly 4,000 feet, in the passes of the Rocky mountains. They give a marked and peculiar character to the scenery of the river valleys, rising like gigantic stairs, to elevations of sometimes more than four hundred feet above the adjoining river or lake. In some places two, three, four and five distinct steps can be seen; while often they have either become merged into one by subsequent denuding agencies,

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* Geo. Sur. of Canada.

or else the precipitous character of the side of the valley has altogether prevented their formation. The steps vary greatly in height, the greatest height observed being as much as one hundred feet ; in width, from one to five chains is not uncommon.

Nearly all the lakes in British Columbia occupy long, narrow depressions in the river valleys, and are, in fact, lake-like expansions of the rivers. There is no doubt that such lakes were at one time much more extended and more numerous than they now are ; and that, in many places, as, for instance, at Lytton, and on the north bend of the Thompson, and at Canoe river crossing, the terraces mark the old margins of these lakes, while in others they doubtless represent only the ordinary flood-flats of the rivers. The removal of the rocky barriers by which these inland waters were confined would result in the formation of such gorges and canons as we now find on the Fraser at Gale, and below Lytton, as well as on the North Thompson at Murchison's Rapids, and on Canoe river below the wide flats at the crossing, and would, without any general movement of elevation, drain off the waters of the lakes, leaving the old shore lines exactly as we now see them, at corresponding heights on both sides of the valleys. Ordinary alluvial river flats do not commonly occur in that manner, but where a flat occurs on one side there is usually a steep bank on the other, and especially is this so along rapid rivers which traverse a mountainous country.

Dr. F. V. Hayden* said, that Fort Bridger is located in what appears to the eye a sort of basin, inclosed by high, arid table lands, but really in a central portion of the drainage of Black's Fork. The beautiful valleys, Smith's, Black's, and Muddy, have been carved out of the horizontal strata, and between the streams are terraces and flat table lands, which give a singular outline to the surface of the country. No forces now in operation, in this vicinity, could have given the existing features to the surface of the country, and the cause must have been local, proceeding from the northern slope of the Uintas. The beautiful table-top divides between the valleys, and streams are extensions into the plains of the radiating ridges of the mountain slope, and are literally paved, in many places, with the water-worn bowlders of the purplish sandstones and quartzites, and with the carboniferous limestones that compose the nucleus of the Uinta range. Here and there we can see a flat-topped butte cut off by erosion from some of the intervening ridges, and rising above the surrounding country as

* U. S. Geo. Sur. of Wyoming.

a partial witness to the extent of the denudation. A little south of west of Fort Bridger, is an isolated butte called Bridger's Butte, which forms a prominent land mark to the traveler, and according to the barometer, rises 750 feet above the valley of Black's Fork, at the fort. The summit appears perfectly level, and was estimated to be about two miles in length, from north to south, and about a fourth of a mile in width, from east to west. The upper portion of the butte is composed of the somber, brown, indurated, arenaceous clays, gray and rusty brown sandstones of the Bridger Group, passing down into limestones and marls of the Green river beds. In the brown clays are abundant remains of turtles, with a few fragments of other vertebrate remains. The terraces along the valley of Black's Fork, are composed of yellowish and whiteish gray marls, and chalky limestones, some of the layers mostly formed of *Unio*, and other fresh-water shells. A few plants were found in the valley of Smith's Fork, in thin black, flinty layers, mostly ferns and leaves of deciduous trees. Between Fort Bridger and Henry's Fork, the indurated, arenaceous clays, of the Bridger Group, are weathered into remarkably unique forms. The absence of harder layers of sandstone did not admit of the weathering into pinnacles, turrets, steeples, domes, etc., as observed near Church Buttes. The surface, though very rugged and almost impassable, except along the valleys of the streams, is much more rounded ; the hills are more dome or pyramid shaped, and entirely destitute of vegetation, except the sage, and several varieties of chenopodiaceous shrubs. Passing up the Cottonwood Fork, the marls and limestones make their appearance, for a short distance, in the bluffs. The divide between the drainage of Smith's Fork and Henry's Fork, is a high ridge of the leaden-brown clays of the Bridger Group, which extends up and juts against the base of the Uinta mountains.

From this ridge to Green river, the valley of Henry's Fork forms a remarkable line of separation between the Bridger Group and the lower beds. This line of separation is somewhat of a surface one, yet it is so marked as to attract the attention of the commonest observer. The valley is quite broad, and on the south side the surface of the country to the summits of the mountains appear smoothed downward, in part grassed over. A close examination will detect some thin remnants of the Bridger Group underlaid by lower Tertiary beds, which have a tendency to weather into rounded, gently-sloping hills. On the north side, the arid, rugged, " bad lands" are very conspicuous, and rise up somewhat abruptly like a high wall. On the north side of the creek, there is a great thickness of the indurated clays of the Bridger Group.

There seems to be no unconformability of the beds included in this Group, and the different beds pass from one to the other gradually; but to the leaden-gray, somber, indurated, arenaceous clays, which cover a large area east of Fort Bridger, and weather into such unique architectural forms, and contain a large variety of vertebrate remains, Dr. Hayden gave the provisional name of the "Bridger Group." The calcareous layers which underlie the Bridger Group, and are so well displayed lower down on Henry's Fork, he referred to the "Green river Group." Intercalated with the clays of the Bridger Group are beds of rusty-brown and gray sandstones, all tending to a concretionary structure, and disintegrating by exfoliation in thin concentric layers. Sometimes there are beds of sandstone which form an aggregate of concretions. In the whole mass, arenaceous materials predominate. As we descend, the calcareous sediments prevail, until chalky limestones and marl are greatly in excess.

The Green River Group is seen to the best advantage along the valley of Green river, where the sides of the bluff blanks rise to a perpendicular height of 500 feet or more. Ten miles east of Green river Station, the Green River Group disappears abruptly on the south side of Bitter creek, and the coal formations come up to view. On the north side, the eastern limit of the Green River Group is most sharply marked by a long, high, white bluff, that extends off, far to the northeast toward the South Pass.

The dip varies from 3° to 5°, and the laminated calcareous shales gradually pass down into yellow, gray, and brown indurated arenaceous clays, sands, and sandstones, until the well-defined coal strata are exposed, without the least appearance of discordancy.

In traveling from Bear river to Great Salt Lake valley, soon after leaving Carter station, toward the west, pinkish Tertiary beds are observed. They seem to rise from beneath the Bridger Group. Their dip is about northeast 3° to 5°, and they have evidently been disturbed slightly by the later movements which elevated the Uinta range. They are composed of red, indurated, arenaceous clays, with beds of grayish and reddish-gray sandstones alternating; and for this series of strata Dr. Hayden proposed the name of the "Wasatch Group." Pinkish and purplish clays are the dominant features, and give the lithological character of the group as far west as Echo canon, when the conglomerates prevail. The latter is full of beds of sandstone, largely concretionary, but the sandstones or harder layers are seldom of a reddish color.

[To be Continued.]

TWO NEW SPECIES OF ENTOMOSTRACA.

By V. T. Chambers.

Tachidius (?) fonticola, n. sp.

Plate A.—See figs. 1 to 11 inclusive.—1, T. fonticola; 2, its inferior palpus, male and female; 3, female antenna; 4, female legs of 2d, 3d, and 4th pair; 5, female leg of 1st pair; 6, female appendage to 6th segment; 7, do. of male; 8, male antenna; 9, male leg of 1st pair; 10, male leg of 2d pair; 3d is like it, except that the terminal setæ are longer, as long as those of the 4th pair; 11, male legs of 4th pair.

The animal is pale yellow, with the eye spot very large and bright crimson. The antennæ of the female are short, thick, and simple ; those of the male are six jointed, and as shown in figure 8; the setæ of the legs of the female are much shorter than those of the male. Length of body, .385 mm., that of terminal setæ is .3 mm. The armature as to spines, etc., is sufficiently given in the figures.

So far as is known, this species does not inhabit a portion of the earth's surface more than two yards square. At the famous locality known as Big Bone Springs, large "Gums" (hollow trunks of trees) are sunk in the ground, and the water of the springs rises up in these Gums, and running over the top spreads out over the ground, or runs off in small streams. At one of these springs, which is near the edge of a bank of Big Bone Creek, the water spreads over the ground toward the bank over which it trickles. There is not enough of it to form a stream, spread out thus, and quickly absorbed in the ground as it is, but it affords a fine place for the growth of a species of *Oscilatoria* (probably *O. imperator*, Wood), which forms a tolerably thick mat, upon the surface, and in which *T. fonticola* lives in countless multitudes. All the species of *Tachidius* heretofore known live in salt seas, or in brackish water connected with them. How this little creature found its way to its present habitat is a mystery. I have no analysis of this water by me, but the water of all of these springs is strongly impregnated with common salt, iron, sulphur, and other mineral ingredients in less quantity. I found only the *Tachidius* and *Oscillatoria* growing at that place, but in the water of another spring, containing a smaller percentage of mineral matters, I found the species of *Cypris*, a dipterous larva, and several *infusoria* (*Paremecium*, Monads, etc.) But I found no animal or vegetable organisms in any of the "Gums" in which the water is very cold. It was only when it spreads around the spring, or stands in little puddles, that I found the creatures above mentioned, but this standing water outside of the "Gums" was warmed by the sun, and by reason of evaporation was more strongly saline than that in the "Gums." The legs of the *Tachidius* seemed formed for swimming, but there was scarcely water

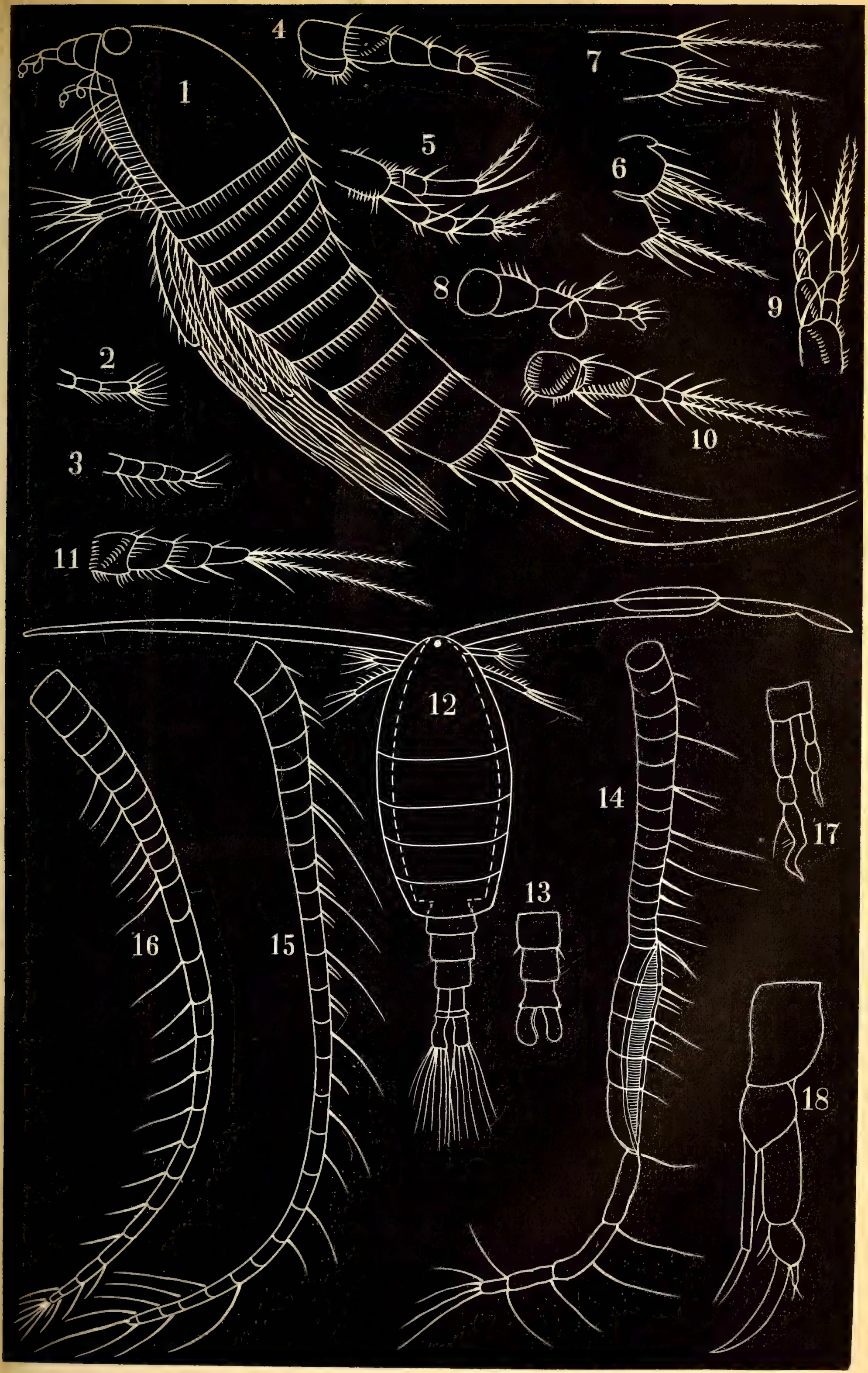
enough even for so small a creature to swim. The legs of the female seem, however, scarcely so well adapted for swimming as those of the male. I refer the species provisionally to *Tachidius*, as it seems to belong there more properly than in *Canthocamptus*.

DIAPTOMUS (?) KENTUCKYENSIS, n. sp.

Plate A and B.—Figure 12, *Diaptomus* (?) *kentuckyensis*. The outer line represents the male; the dotted inner line the outline of the female; fig. 13, abdomen of female; fig. 14, right antenna, male; fig. 15, left antenna, male; fig. 16, antenna of female; fig. 17, posterior foot, male; fig. 18, last foot of male; fig. 19, maxilliped of first pair, female; fig. 20, antenules male and female; fig. 21, mandible; fig. 22, 2d swimming foot, female; fig. 23, first swimming foot of female.

The species is white and transparent. The abdomen of the male has five, that of the female only four segments. *Cephalathorax* with five distinct segments, but when crushed under pressure the head appears to divide into four segments. The organs as represented in the figures,—length from apex of head to end of terminal setæ, 1.5 mm. Antennæ as long as the body.

For several years in succession, I have taken it from the same spot, in a small lake or pond, in Linden Grove cemetery, in Covington, Kentucky, in May; but have not met with it elsewhere. The differences in the male and female abdomen, suggest a doubt whether it properly belongs in *Diaptomus*, which strictly has five joints in the abdomen in both sexes. The thorax here has only four distinct segments beside the head, though under pressure the head and thorax may be separated into nine segments. In *D. castor*, according to Baird, the antennæ have twenty-six joints. In this species the right antenna has only twenty-four in the male, and the left has twenty-six; otherwise it is very similar to the same organ of *D. castor*, except as to the number, position and character of its ciliæ, as to which it differs decidedly, since according to Baird, *D. castor* has each joint furnished with one or more setæ, and the terminal one with five (see fig. 14 as to this species). *D. castor*, according to Baird, has the short branch of the antenule, consisting of six joints. In this species, the articulation of this joint is very indistinct, and there are, I think, ten joints, some of them being very small and indistinct; there are nine plumose setæ, each of which appears to me to spring from a distinct joint. Baird's first joint seems to me to be resolvable into three; the second branch is longer than the first. This species is evidently quite distinct from *D. castor*, and it may be doubtful whether they should be placed in the same genus. It is also evidently quite distinct from *D. pallidus*, Herrick; and from *D. longicornis*, Herrick; and from all the other species with which I am acquainted, especially as to the different numbers of joints in the abdomen in the sexes.



[PLATE A.

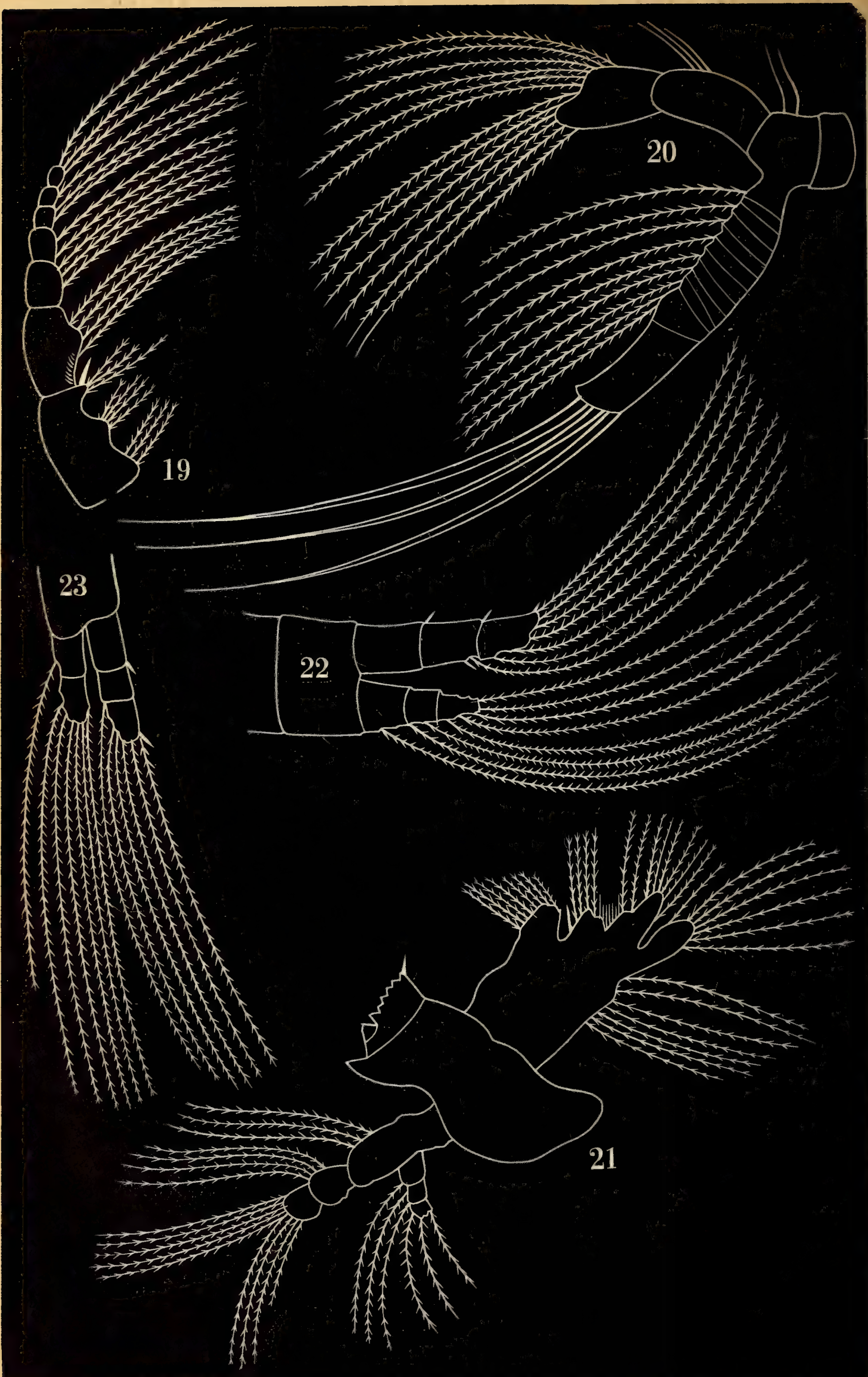


PLATE B.]

ON THE GEOGRAPHICAL DISTRIBUTION OF THE INDIGENOUS PLANTS OF EUROPE AND THE NORTHEAST UNITED STATES.

By JOSEPH F. JAMES.

It has long been a matter of considerable interest to botanists, to observe the fact that in every country there are found some species of plants common to some other country, perhaps thousands of miles away ; and much speculation has been indulged in to account for the causes which have led to this apparently capricious distribution. The subject of the Geographical Distribution of Plants has occupied the minds of some of the most eminent men of our time, and Humboldt, De Candolle, Hooker, and Gray, have followed one another in rapid succession. Much as has been done, still more remains, and I purpose as a contribution to the subject, to take a view of the Geographical Distribution of the Indigenous Plants common to Europe and the Northeast United States, and to indicate the reasons for the resemblances between the floras of the two continents.

Modern science has been so revolutionized in the last twenty years, caused primarily by the publication of the "Origin of Species," that scarcely any one now believes in the assertion of an eminent authority,* that "there is indeed nothing more easy to perceive, in the distribution of organic beings over the globe, than the universal law, that nature, in similar circumstances, has always produced similar or perfectly the same creatures." Such used to be the belief, but now there are but few scientific men who do not believe in the evolutionary hypothesis as postulated by Darwin ; who do not believe, as Wallace has expressed it, that "every species has come into existence, coincident both in space and time with a pre-existing closely allied species."† Therefore, when we find identical species in two different quarters of the globe, we believe the individuals in both localities to be descended from a common parent.

In order to account for many facts in the distribution of plants and animals, long periods of time must be allowed. There is no evidence to prove that the American continent is of such recent origin as to merit the title of "New," in contra-distinction to the "Old World." On the contrary, the evidence points in the other direction. Geologists generally have now come to the conclusion that the great land masses

* Meyen, Geog. of Plants, Pub. of Ray Society, 1846, p. 265.
† Wallace, Contr. to Nat. Selec., N. Y., 1871, p. 5.

of the earth have not been subjected to such upheavals and depressions as was once supposed; but that they have, instead, retained, in a remarkable degree, the same shape and general positions they now have, for immense periods of time.* Especially must this be the case with America. In South America the immense alluvial deposits of the Amazonian valley, principally the result of the wear of ages on the masses of the Andes, have been formed since the last great change in the contour of the continent. In North America the alluvial deposits of the Mississippi valley, covering an area of 30,000 square miles, in places 100 feet in depth, are supposed to have taken at least 100,000 years to form,† and the balance of the continent must be immensely more ancient. No other such deposits as these can be found in the world, and on this ground alone the immense antiquity of the whole American continent can be maintained.

The fauna of North America points to the same conclusion. The remains of animals found in the Tertiary deposits of the Western United States indicate great antiquity, and the one family of horses alone would require a very long period of time to become differentiated into the many forms of which we now find remains. Among living forms is the large family of Humming birds, confined entirely to the American continent, and consisting of 118 distinct genera, and 400 species. Mr. Wallace believes that this family originated in the tropical forests of the once insular Andes, and has become differentiated into so many distinct forms, because of the stability of the country, and the long continued existence of the present climatic conditions.‡

It can not, then, be asserted that we have not a long period of time during which our plants could have been distributed, and there have been many causes which have helped to bring it about. I have elsewhere§ referred to certain agencies which are, or have been, very efficient in the work, and to one or two of them I wish to call your attention.

No one now denies the fact that in times long past, the northern hemisphere down to the 40th degree of latitude in North America, and the 50th in Europe, was subjected to intense cold, and this period is known as the glacial epoch. Opinions differ as to the cause of the cold, and many theories have been advanced to account for it. One of

* Wallace, Tropical Nature, pp. 312, 313.

† Lyell, Antiquity of Man, p. 46.

‡ Geog. Dist. of Animals, II., p. 322. See also Essay on Humming Birds in "Tropical Nature," p. 124, *et seq.*

§ Popular Science Monthly, July, 1880.

the most probable is that advocated in that very valuable book on "Climate and Time," by Mr. James Croll. His idea is that the high eccentricity of the earth's orbit some 250,000 years ago, brought into play certain physical agencies which ultimately brought the glaciers over the country. This eccentricity of the orbit caused the warm currents of the Atlantic Ocean to be deflected into the Southern, instead of continuing to flow into the Northern hemisphere, thus depriving the latter of at least one fifth of the entire heat it received. In consequence of this loss, the annual temperature was greatly lowered. Snow fell in the high northern regions in such quantities that, instead of melting, it kept accumulating year after year, and century after century, until a large part of the land in the Northern hemisphere was covered with a sheet of ice, varying from 2,000 to 12,000 feet in thickness.*

With such a mass of ice covering the country, all animal and vegetable life must either have been destroyed, or else forced to migrate southward toward warmer regions. At this period the southern polar seas were nearly or quite free from ice, and all that hemisphere was enjoying a temperate and equable climate. But after a long interval there came a change. The currents of the ocean were again deflected, this time to the north ; the same agencies piled the ice on the South Pole which had caused its accumulation at the North, and the latter in its turn enjoyed an equable and temperate climate. With the gradual abatement of the cold, such forms of life as had been preserved in milder regions, would retire again to the north. Some would reach their old station near the Arctic circle, but others would retire up mountains which lay in their way, and finding suitable conditions of climate and station, would there establish themselves.

All around the Arctic circle before the glacial epoch of the north commenced, grew plants of temperate climes. The oak, the elm, the beech, the maple, the sycamore, the pine, and many others flourished in luxuriance. As far north as latitude 70°, abundant remains of *Sequoia langsdorffii* have been found. Its modern representative, *S. sempervirens*, at present growing only in limited localities in California, requires a temperature of 49° during the whole year for its development ; and it must have been at least that as far north as 70°

* Researches show that the former must have been the thickness of this sheet in Scotland, for unmistakable glacial markings have been found on the tops of mountains 2,000 feet high (Climate and Time, pp. 439-442). And Dana in an article in Am. Jour. Sci. and Arts, 3d series, vol. v., p. 205, *et seq*, gives the thickness of the New England ice sheet at 6,500 feet, and says that on the north it "was not less than 12,000 feet."

when *S. langsdorffii* lived there.* Innumerable herbaceous species, too, found suitable homes in the forests and plains of the north at that time ; and as the same species of plants live to a greater or less extent all around the Arctic circle at the present day, there is no reason to suppose it was otherwise then.

With all this luxuriant vegetation at the North Pole, let us suppose the cold period to begin. Such species as were capable of so doing, gradually worked their way further and further from the land of their birth, driven by the increasing cold of each successive year. If we suppose a distance of 600 miles to separate two groups of one species at 80° of latitude, and suppose they migrated in a direct line south, we find that when latitude 50° was reached, no less than 2,700 miles would separate species and descendants of individuals which had been before living near together. Or if a species had lived at the Pole, and some individuals had gone one way, and some the opposite, when their descendants reached temperate regions, we would find them on opposite sides of the globe, without, perhaps, being found in intermediate localities.

The remarkable fact that some species of plants of the Arctic regions and of Europe, are identical with some found on the Chilian Andes, the Antarctic Islands, in Australia and New Zealand, can be explained on the same theory. The Rocky Mountains and the Andes form a highway which would facilitate the passage of various species. And when the Arctic forms were forced south by the cold of the glacial epoch, the mountains of the Andes would take them to or beyond the equatorial regions, and furnish them homes until the cold commenced in the Southern hemisphere. Then they would descend to the plains, mingle with the forms from the Antarctic regions, and finally take up their abode at the extreme southern end of the continent.

There is, doubtless, a considerable area of land around the South Pole, and if the theory of glacial and interglacial (warm) periods be a correct one ; and if the Antarctic seas and continents were at times free from ice and snow, and enjoyed a climate similar to that which temperate regions now have, the similarity which has been noted† between the Alpine floras of the South American Andes and New Zealand, will be explained. The lower end of the American continent is not so very far away from New Zealand if we take the distance in a

* Croll, Climate and Time, p. 310.
† Hooker Intro. Essay to Flora of New Zealand, p. xxiv.

direct line across the South Pole ; and with even a moderate amount of land intervening, it would not be very difficult for plants to find their way from one country to another, The similarity between the floras is abundantly illustrated by a table of fifty-five species of plants of temperate and cold South America, which represent the same number of species in New Zealand and Australia. There are really 89 species, or nearly one eighth of the flora of New Zealand, which are also South American.*

The same explanation of the glacial epoch would account for the finding on the mountain of Kini-Balu, in Borneo, at 8,000 feet elevation, of three very peculiar Antarctic, Tasmanian and New Zealand genera, viz.: *Drapetes*, *Phyllocladus*, and *Drimys*, "which are almost unknown in the northern hemisphere."†

Having now shown that the long periods of time necessary for the wide distribution of plants are granted by the antiquity of the American continent, and explained the importance of the glacial epoch to the theory, I shall now proceed to show the similarity existing between the floras of Europe and the northeastern United States, and show reasons for expecting this similarity. It has existed for a long time. In the Cretaceous rocks of Kansas and Nebraska, are found many plants of existing genera. The species of these genera are, many of them, closely allied to those now living in America. When we turn to Europe, and compare our fossils with those of the Cretaceous formations there, many of the species are found to be identical in both formations.‡ Not only this, but we find in the Cretaceous rocks of Greenland, in 70 deg. N. latitude, the same fossil forms that formerly lived

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* Hooker Intro. Flor. New Zealand, pp. xxx-xxxvi. While on this subject, it might be well to state that Dr. Hooker found it difficult to account for the fact that though many typical genera and species of New Zealand were found in Australia, only a few peculiar genera and species of Australia were found in New Zealand, though they were well adapted for transportation by ocean currents. The difficulty is partly solved when we find that the ocean currents run from New Zealand toward Australia, instead of in the reverse direction. Seeds could then only be transported from the former to the latter. Mr. Wallace, in his new book, on "Island Life," suggests another explanation. He supposes Australia to have been divided during the Cretaceous period into two islands, the Temperate on the west, and the Tropical on the east. The eastern island was united to New Zealand by a spur of land, which allowed an interchange of fauna and flora, while the west island never was united to New Zealand. Finally, the channel which separated the east and west islands of Australia was closed, and New Zealand and East Australia were separated. If this explanation is the true one, then the greatest similarity should exist between East Australia and New Zealand; and the greatest difference be found between New Zealand and West Australia. This has been found to be the case, and the data can be found in Dr. Hooker's essay, "on the Flora of Australia," 1859, pp. l-liv.

† Hooker, Flora New Zealand, p. xxxvi.

‡ See Lesquereux, Cretaceous Flora of the W. U. S. In U. S. Geo. and Geog. Sur. of Terr., Wash., D.C., 1874, vol. vi.

in temperate Europe and America. One of the most remarkable of these is a species of *Sequoia*. So similar are the fossils to the species now living in California, that there is no doubt but that they are the ancestors of our living trees. It may seem strange to some, to call to mind the fact that California is at present the only place where these trees now grow, when we know that they once flourished over a much more extensive area. But when we see the peculiar character of the California climate, when contrasted with that of Europe, Eastern North America, and Eastern Asia, at the present day, we are forced to the conclusion, that in their present situation only have they found the necessary requisites of their growth. It is to be feared that these remarkable forms of vegetation, connecting links between the past and the present, are now on the highroad to extinction; and in a few more decades they will be almost unknown in a wild state, and exist in history as another example of the destructive powers of mankind.*

The species of plants which are, according to Gray's Manual of Botany, common to Europe and Northeast United States,† can be divided into four classes. First, the strictly Alpine species, found mostly on the highest summits of the White mountains, the Adirondacks, and in other elevated localities. The distribution of all these species, I believe to have been effected by means of the glacial period, as already explained (ante p. 54). The species are as follows :

List No. I.—Strictly Alpine species, all having a north or northwestward range.

1. Cardamine bellidifolia.
2. Viola palustris.
3. Silene acaulis.
4. Sibbaldia procumbens.
5. Potentilla frigida.
6. Saxifraga rivularis.
7. Saxifraga stellaris, var. comosa.
8. Epilobium alpinum.
9. Epilobium alpinum var. majus.
10. Gnaphalium supinum.
11. Vaccinium uliginosum.
12. Arctostaphylos alpina.
13. Cassiope hypnoides.
14. Bryanthus (Phyllodoce) taxifolius.
15. Rhododendron lapponicum.
16. Loiseluiria procumbens.
17. Veronica alpina.
18. Castilleia pallida.
19. Euphrasia officinalis.
20. Diapensia lapponica.
21. Polygonum viviperum.
22. Oxyria digyna.
23. Empetrum nigrum.
24. Salix herbacea.
25. Luzula arcuta.
26. Luzula spicata.
27. Juncus trifidus.
28. Scirpus cæspitosus.
29. Carex scirpoidea.
30. Carex capitata.
31. Carex vitilis.
32. Carex rigida.
33. Carex atrata.
34. Phleum alpinum.
35. Agrostis canina.

* Address by Prof. A. Gray, before Am. As. Adv. of Science, 1872. Reprinted in Darwiniana, p. 200.

† All States north of Tennessee and North Carolina, and east of the Mississippi river.

36. Poa laxa.
37. Festuca ovina.
38. Triticum violaceum.
39. Aira atropurpurea.
40. Hierochloa alpina.

These forty species comprise all those found in our Alpine region ; and there are but nine species found here, which are not also found in Europe. These are as follows :

Arenaria grœnlandica.
Geum radiatum, var. Peckii.
Solidago thrysoidea.
Arnica mollis.
Nabalus boottii.
Nabalus nanus.
Vaccinium cæspitosum.
Salix cutleri.
Calamagrostis pickeringii.

The first, though not occurring in Europe, is an Alpine and Arctic form, and has been found in Greenland. *Geum radiatum* is a native of the high mountains of Carolina, and the variety only is a northern Alpine form.* *Solidago thrysoidea*, is very near European form of *S. Virg-aurea*† (also found in America), and may be a geographical variety. *Vaccinium cæspitosum* is found in Labrador, and as far north as Alaska. The few remaining may be forms which have been developed from others, on account of the struggle for existence which ensued when left on the mountains during their return to the north at the close of the glacial epoch.

The second list consists of sub-Alpine and other species, having a north or northwestward range ; and the distribution of these admits of the same explanation as No. I.

List No. II. — Sub-Alpine and other species, having a north or northwestward range.

Anemone nemorosa.
Anemone (Hepatica) triloba.
Ranunculus repens.
Coptis trifoliata.
Actæa spicata, var. rubra.
Cardamine pratensis.
Arabis petræa.
Arabis hirsuta.
Arabis perfoliata.
Barbarea vulgaris.
Erysimum cheiranthoides.
Draba incana.
Draba nemorosa.
Viola selkirkii.
Viola canina, var. sylvestris.
Arenaria lateriflora.
Arenaria peploides
Stellaria longifolia.
Stellaria longipes.
Stellaria borealis.
Stellaria humifusa.
Cerastium arvense.
Sagina nodosa.
Lepigonum (Spergularia) rubrum.
Lepigonum salinum.
Lepigonum medium.
Hypericum mutilum.
Geranium robertianum.
Oxalis acetosella.
Astragalus alpinus.
Oxytropis campestris.
Vicia cracca.
Lathyrus maritimus.
Lathyrus palustris.
Spiræa salcifolia.
Spiræa aruncus.
Agrimonia eupatoria.
Dryas integrifolia.
Geum macrophyllum.
Geum strictum.
Geum rivale.
Potentilla Norvegica.

* Gray's Manual, p. 153.
† *Ibid*, p. 241.

Potentilla anserina.
Potentilla fruticosa.
Potentilla palustris.
Fragaria vesca.
Rubus chamæmorus.
Ribes rubrum.
Saxifraga oppositifolia.
Saxifraga aizoides.
Saxifraga tricuspidata.
Saxifraga aizoon.
Sedum rhodiola.
Circæa alpina.
Epilobium augustifolium.
Epilobium palustre, var. lineare.
Linnæa borealis.
Lonicera cærulea.
Viburnum opulus.
Galium aparine.
Galium trifidum.
Galium boreale.
Erigeron acre.
Solidago virga-aurea.
Achillea millefolium.
Artemisia borealis.
Artemisia canadensis.
Gnaphalium uliginosum.
Senecio palustris.
Taraxacum dens-leonis.
Lobelia dortmanna.
Campanula rotundifolia.
Vaccinium vitis-idæa.
Vaccinium oxycoccus.
Arctos taphylos uva-ursi.
Andromeda polifolia.
Cassandra calyculata.
Calluna vulgaris.
Chimaphila umbellata.
Moneses uniflora.
Pyrola secunda.
Pyrola rotundifolia.
Monotropa hypopitys.
Primula farinosa.
Primula mistassinica.
Lysimachia thyrsiflora.
Glaux maritima.
Gentiana (detonsa) serrata.
Pleurogyne carinthiaca, var. pusilla.
Menyanthes trifoliata.
Polemonium cœruleum.
Mertensia maritima.
Convolvulus sepium.
Veronica scutellata.
Veronica serpyllifolia.
Rhinanthus crista-galli.
Pinguicula vulgaris.
Calamintha clinopodium.
Scutellaria galericulata.
Brunella vulgaris.
Stachys palustris.
Chenopodium (Blitum) rubrum.
Chenopodium (Blitum) capitatum.
Atriplex patula.
Coriospermum hyssopifolium.
Polygonum lapathifolium.
Polygonum hydropiper.
Polygonum amphibium.
Polygonum aviculare.
Rumex longifolius.
Humulus lupulus.
Myrica gale.
Beluta alba, var. populifolia.
Alnus viridis.
Alnus incana.
Salix myrtilloides.
Juniperus communis.
Juniperus communis, var. alpina.
Juniperus sabina, var. procumbens.
Taxus baccata, var. canadensis.
Calla palustris.
Sparganium simplex.
Sparganium minimum.
Scheuchzeria palustris.
Habenaria viridis, var. bractrata.
Habenaria hyperborea.
Habenaria obtusata.
Goodyera repens.
Spiranthes romanzoviana.
Listera cordata.
Calypso borealis.
Microstylis monophyllos.
Liparis lœselii.
Corallorhiza innata.
Tofieldia palustris.
Streptopus amplexifolius.
Smilacina stellata.
Smilacina bifolia.
Allium schœnprasum.
Narthecium ossifragum, var. americanum.
Luzula pilosa.
Luzula parviflora, var. melanocarpa.
Luzula campestris.
Juncus filiformis.
Juncus balticus.
Juncus stygius.
Juncus bufonis.
Juncus gerardi.
Juncus alpinus, var. insignis.
Cyperus flavescens.
Scirpus pauciflorus.
Eriophorum alpinum.
Eriophorum vaginatum.
Eriophorum polystachyon.
Eriophorum gracile.
Carex pauciflora.
Carex disticha.

Carex teretiuscula.
Carex teretiuscula, var. major.
Carex chordorhiza.
Carex tenuiflora.
Carex stellulata.
Carex tenella.
Carex vulgaris.
Carex aquatilis.
Carex limosa.
Carex irrigua.
Carex alpina.
Carex livida.
Carex panicea.
Carex panicea, var. refracta.
Carex pallescens.
Carex capillaris.
Carex flava.
Carex viridula.
Carex filiformis.
Carex aristata.
Carex pseudo-cyperus.
Carex miliaris.
Carex rariflora.
Agrostis vulgaris.
Agrostis alba.
Cinna arundinacea, var. pendula.
Calamagrostis stricta.
Calamagrostis langsdorffii.
Calamagrostis lapponicum.
Calamagrostis arenaria.
Kœleria cristata.
Poa annua.
Poa compressa.
Poa alpina.
Poa cæsia.
Poa serotina.
Poa pratensis.
Triticum repens.
Triticum caninum.
Elymus sibericus.
Aira cæspitosa.
Aira flexuosa.
Hierochloa borealis.
Triticum subspicatum, var. molle.
Phalaris arundinacea.
Millium effusum.

The distribution of some of these requires a little explanation. Of the following none are known to pass to the north of latitude 50 deg. in this country, though they are found as far north as 70 deg. in Europe.

Ranunculus repens.
Oxalis acetosella.
Vicia cracca.
Geum rivale.
Geum strictum.
Geranium robertianum.
Veronica officinalis.
Atriplex patula.
Juncus stygius.
Cyperus flavescens.
Microstylis monophyllos.
Humulus lupulus.
Millium effusum.

This apparently anomalous distribution will be explained when we find that the isothermal line of 40 deg. Fahr. passes a little to the south of latitude 50 deg. in North America, and a little to the south of latitude 70 deg. in Europe. It may, therefore, well be that the temperature of this country is not now high enough to allow these plants to pass the 50th deg ; and it is reasonable to suppose that when it was milder the species lived as far north as in Europe.

The true *Betula alba* extends into the Arctic regions in Europe. Our representative of the species, the variety *populifolia*, is not found north of latitude 46 deg. We may, therefore, say that our variety is a southern form, the ancestor of which, at a former period of time, lived in the far north, but owing to an increase of cold it has become extinct, leaving the variety as its southern representative. So, too, with *Taxus baccata*, var. *canadensis*. Our variety is probably the

southern representative of the European form. This variety does not extend further north than latitude 50 deg. on the eastern side of the continent, and "there are yew trees with the port of the ordinary *T. baccata* in Oregon."*

Spiranthes romanzoviana has a peculiar distribution, and though found in this country, from New York to Lake Superior, and northwestward, it is known in Europe in but one place, viz : at Bantry bay, on the west coast of Ireland.† May it not be a waif on the European continent, perhaps carried by birds or the Gulf stream across the ocean? Or is it a remnant of a once more widely distributed species, now confined to a single locality in Europe, but widely distributed in America?

List No. III.—Consisting of species living either entirely in the water, or else in swamps, marshes and wet places. Those ranging north of latitude 50° *marked "N."*

Ranunculus aquatilus, var. stagnalis (N).
Ranunculus aquatilus, var. trichophyllus (N).
Ranunculus flammula, var. reptans (N).
Ranunculus sceleratus (N).
Caltha palustris (N).
Nuphar luteum.
Nuphar luteum, var. pumilum (N).
Nasturtium palustre (N).
Cardamine hirsuta (N).
Drosera rotundifolia (N).
Drosera longifolia.
Stellaria uliginosa (N).
Stellaria crassifolia (N).
Myriophyllum spicatum (N).
Myriophyllum verticillatum.
Hippurus vulgaris (N).
Ludwigia palustris (N).
Ligusticum scoticum (N).
Sium angustifolium (N).
Bidens cernua (N).
Statice limonium (N).
Statice limonium, var. caroliniana (N).
Samolus valerandi, var. americana.
Utricularia vulgaris (N).
Utricularia minor (N).
Utricularia intermedia (N).
Limnosella aquatica, var. tenuifolia (N).
Veronica anagallis (N).
Salicornia herbacea (N).
Suæda maritima (N).
Ceratophyllum demersum (N).
Callithriche verna (N).
Callithriche autumnalis (N).
Speirodela (Lemna) polyrrhiza (N).
Lemna triscula (N).
Lemna minor (N).
Typha angustifolia.
Typha latifolia (N).
Sparganium simplex, var. angustifolium (N).
Sparganium simplex, var. fluitans (N).
Naias major.
Naias flexilis.
Zannichellia palustris.
Ruppia maritima.
Potamogeten natans (N).
Potamogeten rufescens (N).
Potamogeten gramineus (N).
Potamegeten lucens (N).
Potamogeten prelongus (N).
Potamogeten perfoliatus (N).
Potamogeten obtusifolius.
Potamogeten crispus (N).
Potamogeten compressus.
Potamogeten pusillus (N).
Potamogeten pusillus, var. major (N).
Potamogeten pusillus, var. vulgaris.
Potamogeten pectinatus (N).
Triglochin palustre (N).
Triglochin maritimum (N).

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* Gray, Am. Jour. Sci., 2d series, vol. xxiii., p. 67.

† Gray's Manual, p. 505.

Alisma plantago, var. americana (N).
Vallisneria spiralis.
Juncus effusus (N).
Juncus auriculatus (N).
Eriocaulon septangulare (N).
Eleocharis palustris (N).
Eleocharis acicularis (N).
Scirpus pungens (N).
Scirpus supinus, var. hallii.
Scirpus maritimus (N).
Scirpus sylvaticus (N).
Rhyncospora alba (N).
Carex gynocrates (N).
Carex norvegica (N).
Carex salina (N).
Carex maritima (N).
Carex canescens (N).
Carex buxbaumii (N).
Carex fulva.
Carex extensa.
Carex riparia (N).
Carex paludosa.
Leersia oryzoides (N).
Alopecurus aristulatus (N).
Spartina juncea.
Spartina stricta.
Glyceria fluitans (N).
Glyceria maritima (N).
Glyceria distans (N).
Phragmites communis (N).

The plants of this list, as noted at its head, all live either entirely in the water, or else in swamps, marshes or wet places. We know that for some reason or other, all forms of life inhabiting the water, are more cosmopolitan than terrestrial forms. Fishes, aquatic reptiles, fresh-water shells, water mammals, and wading or swimming birds, are all more generally distributed over the world than terrestrial species of the same classes. So, too, it is with plants. These have many facilities for migration, which other forms of life have not. Not least among them is the chance of their being carried in the mud, adhering to the legs, feet, and bills of aquatic and wading birds,* which often range over extensive tracts of country. The water communication existing between the northwest coast of America, and the valley of the Mississippi, forms a natural highway for the migration of aquatic plants. The Yukon, the Mackenzie and its tributaries, the Red river of the North, the Mississippi and its tributaries, the Great Lakes and the St. Lawrence, form an almost uninterrupted water-way from Asia to the United States, and it can not be considered remarkable that 63 out of these 89 water plants have a northern extension, at least as far north as 50 deg. latitude. Of the remaining 23, some special remarks must be made.

Nuphar luteum, the first on the list not found north of latitude 50 degrees, has been found but once in America. "The only specimen seen like European form," says Gray, "was from Manayunk, seven miles below Philadelphia."† Now, as the variety *pumilum*, also a native of Europe, has a northern extension, it is probable that the single specimen may have been introduced in some way, especially as it was found so close to a large city. *Carex norvegica* has also been found

* See Darwin, Origin Species, 6th ed., p. 328.
† Gray's Manual, p. 57.

in but one place in this country, viz: at Wells, Maine, in a salt marsh.* *Carex fulva* has been found but once (at Tewksbury, Mass.) in the United States,† though it grows in Newfoundland, and is scarcely known north of latitude 60 deg. in Europe.‡ *Carex extensa* has also been found in but one locality in America, viz: on the coast of Long Island, on the border of a salt marsh.§ *Carex paludosa* is only known from the border of a salt marsh at Dorchester, Massachusetts, and is perhaps naturalized from Europe.|| We have here, then, five species which are confined to one locality each, and all have been found under such circumstances as to justify the belief that they have been introduced by some agency, since the advent of man in America, and are not properly native.

Drosera longifolia does not grow north of latitude 47 deg. in America; but as it has not been found in Lapland, we may assume this to be a case in which the species is not capable of living now in high latitudes, though it may have done so when the climate was milder. This is the case, also, with the following, none of them growing to the north of 48 deg. latitude in America, nor of 55 deg. in Europe.¶

Myriophyllum verticillatum.	Naias flexilis
Zannichellia palustris.	Ruppia maritima.
Vallisneria spiralis.	Potamogeten compressus.
Typha angustifolia.	Potamogeten obtusifolius (?).
Naias major.	Carex riparia.

Samolus valerandi, of Europe, is represented in America by the variety *americana;* and as this does not extend north of latitude 50 deg. in United States, nor the species above 55 deg. in Europe,** we may understand that the variety flourishes here as the representative of the other form. With *Potamogeten pusillus*, var. *vulgaris*, though the species grows in high latitudes in both Europe and America, the variety does not. The variety *hallii*, of *Scirpus supinus*, is the eastern form, produced probably by climatic or other changes, for the true form is found in Texas.†† The two remaining species, *Spartina juncea*, and *S. stricta* are both found in salt marshes, or on sea beaches. Gray says: "The two species of *Spartina* belong proper-

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* Gray's Manual, p. 578. † *Ibid*, p. 594.

‡ Gray, Am. Jour. Sci., 2d series, vol. xxiii., p. 67. Watson in Geog. Dist. Plants, p. 252, says 55° instead of 60°.

§ Gray's Manual, p. 594. || *Ibid*, p. 596.

¶ See Watson, Geog. Dist. of Brit. Plants, Appendix II. Also, Gray, Am. Jour. Sci., vol. xxiii., pp. 67, 68.

** Watson, *l. c.*, p. 233. †† Gray's Manual, p. 563.

ly to America, being found in only a few places on the coast of Europe, where they seem to have effected a chance lodgment."*

The next list, No. IV., includes all the plants, as far as known, common to Europe and the Northeast United States, not enumerated in the three preceding, and nearly all of them require some special observation. The list is as follows:

List No. IV.

Myosurus minimus.
Cardamine hirsuta, var. sylvatica.
Draba verna.
Subularia aquatica.
Sagina apatela.
Sagina procumbens.
Lepigonum medium, var. melanocarpa.
Oxalis corniculata, var. stricta.
Potentilla argentea.
Circæa lutetiana.
Lythrum hyssopifolium.
Centunculus minimus.
Scrophularia nodosa.
Myosotis arvensis.
Salicornia virginica.
Salicornia fruticosa, var. ambigua.
Salsola kali.
Polygonum erectum.
Polygonum dumetorum, var. scandens.
Rumex maritimus
Castanea vesca, var. americana.
Convallaria majalis.
Cyperus rotundus, var. hydra.
Carex muricata.
Carex limula.
Carex lævigata.
Hordeum pratense.

Taking the first on the list, *Myosurus minimus*, we find it has a scattered distribution. Found from Illinois to Kentucky, thence south and west;† Florida and Georgia.‡ It is given in catalogues of Plants of Indiana,§ of Iowa‖ (at Davenport), and in Kansas.¶ It also grows in Oregon, along with the only other species, *M. aristatus*, which is also found in Chili.** In Europe, it does not extend north of latitude 55 deg.†† Prof. Gray considers that it may have been introduced in our district,‡‡ and even if not it may be considered as coming under those species referred to in List No. II., as not able to live at the north now, though it may have done so when the climate was milder.

Draba verna grows in "sandy waste places and road sides. Not found north of Lower Canada,"§§ and perhaps not so far north, for it is not given in catalogues of Plants of Buffalo nor Chautauqua, N. Y.,

* Gray, Am. Jour. *l. c.*, p. 66.
† Gray's Manual, p. 44.
‡ Am. Jour. *l. c.*, vol. xxiii., p. 381.
§ Bot. Gazette, Feb., 1881.
‖ Arthur's Catalogue.
¶ Carruth's Catalogue.
** Am. Jour., vol. xxiii., p. 382.
†† Watson, *l. c.*, p. 187.
‡‡ Proceed. Am. Ass. Adv. Sci., 1872, appendix.
§§ Gray's Manual, p. 72.

Michigan, Wisconsin, Iowa, nor Kansas. Gray considers it to have been introduced by man. In Europe it is said not to occur north of latitude 55 deg. *Potentilla argentea* is in the same category. It is not known to pass north of latitude 50 deg. in America, although it reaches to 70 deg. in Europe. *Myosotis arvensis* "is not common here, and has probably been introduced."* In Europe, it is found as high as 70 deg. latitude.†

Subularia aquatica is a rare plant in North America, having been found only in Maine and New Hampshire.‡ "From its size, aspect and place of growth, it is exceedingly liable to be overlooked" (Gray). In Europe, it is found as far north as 72 deg. latitude.§ *Sagina apatella* is found in "Dry soil, N. Y., and Penn. to Ill., scarce, seemingly native."‖ It is not given in catalogues of plants of Buffalo, Chautauqua, Dist. Columbia, Michigan, Ohio, Iowa, Kansas, Wisconsin, nor Canada. It must be, therefore, either very scarce or easily overlooked, and has most likely been introduced in some few places. It does not extend further north than latitude 55 deg. in Europe.¶

The following ten species are all found in this country, at least as far north as latitude 50 deg., and none of them extend north of latitude 55 deg. in Europe. Their distribution is explained under the rule already laid down in regard to some species of List No. II. (*ante* p. 59), only in this case they stop at 55 deg. in Europe, instead of extending to 70 deg. as do the former ones.

Sagina procumbens.	Centunculus minimus.
Circæa lutetiana.	Rumex maritimus.
Scrophularia nodosa.	Carex muricata.
Salsola kali.	Carex lævigata.
Lythrum hyssopifolium.	Hordeum pratense.

Of the following all are varieties of European species. Sometimes the species and variety are both found here, and sometimes the latter only. In the former case, it is found that the variety is the more common to the southward, if not wholly confined there. In the latter case, we may consider that we have here cases in which the species has varied to a certain degree in the south and been maintained there, while the parent species has ceased to live at the north on account of the cold. These species are as follows :

* Gray, Am. Jour., *l. c.*, p. 65.

† Watson, *l. c.*, p. 65.

‡ Gray's Manual, p. 73.

§ Watson, *l. c.*, p. 191.

‖ Gray's Man., p. 94.

¶ Watson, *l. c.*, p. 195.

Cardamine hirsuta, var. sylvatica.
Lepigonum medium, var. macrocarpa.
Oxalis corniculata, var. stricta.
Salicornia fruticosa, var. ambigua.
Polygonum dumetorum, var. scandens.
Castanea vesca, var. americana.
Cyperus rotunda var. hydra.

There remains now of list No. IV. but four species. Of these *Salicornia virginica* has been rather doubtfully identified with *S. mucronata* of the coast of Spain. *Polygonum erectum*, a very common plant around all houses, has doubtless been introduced by man. *Carex limula* has been rather doubtfully identified with the Lapland plant, by Wm. Boott.* There then remains only *Convallaria majalis*. This is known to grow in this country only on the mountains of Georgia and North Carolina, " and extends north to the peaks of Otter, in Virginia, latitude 37½ deg., at an altitude of 4,000 feet ; but it is not known to occur anywhere beyond this; while in western Europe it extends nearly to latitude 70 deg."† This certainly is a remarkable case, and is difficult to account for. It is hardly possible it has been overlooked, for it is too striking a plant. I have a specimen, collected in Massachusetts, escaped from cultivation, and it is given in the catalogue of Plants of Wisconsin. It seems to be in much the same position on the Atlantic coast, as *Sequoia* is on the Pacific ; now confined to limited localities, though once ranging over wide tracts of country.

Enumerated in the four preceding lists, there are 360 species and varieties of plants. A reasonable explanation of why they are found in both Europe and America has been given. But as a foundation for the explanation, two things must be admitted. First, that the region surrounding the North Pole has been the source from which has been derived a good part of the floras of Europe, North America, and Asia ; and, second, the occurrence of glacial and inter-glacial (warm) periods both north and south.

As for the first, the region close around the North Pole is, as yet, a *terra incognita*. We know enough of it, however, to say with certainty that there is considerable land clustered in its vicinity. We may very reasonably suppose, that during the warm period at the North, the ocean was at a lower level than it is now,‡ and that a land connection formerly existed between the northwest coast of America, and

* Gray's Manual, p. 582.

† Am. Jour. *l. c.*, vol. xxiii., p. 64.

‡ In consequence of the withdrawal of large quantities of water to form the Antarctic ice cap; and because the shifting of the earth's center of gravity caused by this ice, would have a tendency to draw the water toward the south, thus leaving much dry land at the north. Croll, " Climate and Time."

the northeast coast of Asia.* With this connection the facilities for migration would be greater, and would be decidedly taken advantage of by animals and plants. There is also the same reason for supposing that, during that period, the stretch of ocean between Greenland, Iceland, and the northwest of Europe, was much less than it is now, even if the continents were not actually united. We know, further,† that at a former period of time, the climate there was such as to admit of the growth of plants, which are now strictly confined to temperate regions; and which certainly could not grow under the climatic conditions existing at the present day in the countries under the Arctic circle.

The resemblance between the floras of Europe and the United States, is by no means confined to the 360 identical species. There are, besides, many closely related species, some of which may be reduced to geographical varieties; and a still larger number of strictly representative species, not likely to be confounded.‡ If to the identical species we add these related and representative species, we shall find that one third of the 2,277 indigenous species given in Gray's Manual, resemble European forms. But the similarity between the floras of North America and Europe, is by no means confined to the small territory with which I have been dealing. I selected the portion covered by Gray's Manual, because the country has been more thoroughly explored, and because the facilities for getting imformation are better than for other and larger tracts of country. It is well known that many European forms extend along the Rocky Mountains to Colorado, and other elevated localities, and I have no doubt but that a comparison of the entire flora of the United States (excluding the semitropical one of California, which really belongs to the Mexican region), will show nearly as much resemblance as I have shown exists in the small territory here dealt with.

As for the glacial period and its effects upon the country, few are now inclined to deny it; and they grant not only the occurrence of cold periods but of warm ones intervening. Undoubtedly we may look to the north for the place of origin of many of our species of plants; and in the glacial theory will find the principal factor for the dispersion of the species from the place of their origination.

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* A rise of less than 200 feet would form this connection. Croll estimates that the fall of the level of the ocean in consequence of the withdrawal of water, was some 600 or 800 feet at Edinburgh, and would be more further toward the north.

† By the discovery of fossil plants at Disco, Greenland, and other places, and by the abundant coal fields of high northern latitudes.

‡ For some of these species, see Am. Jour. Sci., *l. c.*, vol. xxiii., pp. 80-85.

Prof. Gray has made it well known that there is far more resemblance between the plants of the Atlantic coast of the United States, and the Pacific coast of Asia, than between the latter and the Pacific coast of America, especially of California. But this can not be considered so very remarkable when we come to note the very marked difference in the climate between the two sides of the continent. The Eastern and the Asiatic climates resemble each other very much more than the Californian. In the first two we have four well marked seasons, characterized by abundance of moisture, while in California there are but two, the wet and the dry, as in tropical countries. The dry season is so severe as to cause the death of all plants for whose growth continual moisture is necessary; and we find that the majority of plants common to eastern North America and western Asia, but absent from California, are among the very ones for whose growth, moisture, and especially shade, is necessary. Of the latter, many parts of California are utterly destitute. In reality we have, in California, a continuation of the climatic conditions existing in Mexico and the semi-tropical parts of America; and not only is the flora closely allied to that of Mexico, but the fauna also. It forms a separate region in Wallace's "Distribution of Animals," and must, in any general classification, be separated from the rest of America, because of many peculiarities. We have, therefore, many good reasons for not finding there more than 76 species out of 258 living in America and Asia.

To sum up our observations, then, we find:

1st. That the time necessary for the distribution of our plants has been sufficiently long.

2d. That the species of plants common to Europe and America have had a common origin in the land about the North Pole.

3d. That they have migrated south on account of the cold in the Arctic regions.

4th. That on account of present climatic conditions, some species reaching a high latitude in Europe are not found in America as far north by 20 deg.

5th. That the chain of the Rocky mountains, and the Andes, furnishes, or has furnished, a highway for the dispersion of some Arctic forms over the southern hemisphere. And

6th. That the similarity between the floras of Europe, of Northeast Asia, and Eastern America, is greater than that between Asia and the American Pacific coast, on account of the great difference in climatic conditions, and because of the closer connection which exists between California and the semi-tropical region of Mexico.

DESCRIPTION OF THE YOUNG OF THE GRIZZLY BEAR —URSUS HORRIBILIS.

By Charles Dury.

Plate III., natural size; three days old.

The fine pair of grizzly bears, presented to the Zoological garden by Mr. J. J. Bantlin, have, for the third time, brought forth young. The adults are now eight years old. The first cubs were born January, 1876, and immediately eaten up by their mother.

January, 1878, two more were born, and were overlaid, after living three days. They measured 10¾ and 11½ inches respectively, from the tip of the nose to the end of the tail ; eyes, tightly closed. On January 10, 1881, the female was delivered of the last, a litter of three. Through the kindness of Mr. Frank J. Thompson, superintendent of the garden, I have been permitted to examine these most interesting specimens and to secure the following data in regard to them.

Mr. Thompson informs me that the period of gestation is within a day or two of nine months, he having carefully observed their actions while he has been in the garden. At first sight, one is impressed with the very small size of the cubs in proportion to the great size of the parents. Shortly after the birth of the third cub, the mother came away from them, and it was decided to remove them and try to rear them by hand. When brought away, and warmly wrapped in Angola goat skin, the little creatures sucked readily from a bottle filled with cow's milk. They were very strong and vigorous, and when chilled or handled, manifested their displeasure with vociferous yells, that in tone resembled the cries of a very young human infant.

Measurements and weights were as follows :

1st. Length from tip of nose to end of tail, 9⅛ inches; circumference of body, behind fore leg, 8¼ inches; length of foreleg, from head of humerus to claw, 3½ inches; claw of forepaw, 5-16ths inch; girth of head, 5¾ inches; length of head, 2½ inches; weight, 1 lb. 3½ oz.

2d. Length, from tip of nose to end of tail, 10¼ inches; girth, 8 inches; foreleg, 3½ inches; weight, 1 lb. 2½ oz.

3d. Length, 9½ inches; girth, 7½ inches; weight, 1 lb. 2 oz.

Color.—The body was of a dusky flesh tint, thickly covered with short, stiff hair, of a dirty white color, with a broad dorsal line of ash colored hairs, from the occiput to the tail. The face was rich flesh color. The nose reddish pink, as were also the ears. The soles of the feet were bright carmine pink. Eyes, tightly closed. The subject of the illustration was 3 days old.

DESCRIPTION OF SOME NEW AND REMARKABLE CRINOIDS AND OTHER FOSSILS OF THE HUDSON RIVER GROUP, AND NOTICE OF STROTOCRINUS BLOOMFIELDENSIS.

By S. A. Miller, Esq.

Palæaster exculptus, n. sp.

Plate I., fig. 1, natural size.

Pentagonal; rays a little longer than the diameter of the body; diameter of the body about 93-100 inch; length of ray measuring to the center of the body or disc, about 1½ inches; breadth of a ray at the junction with the body, about 57-100 inch; rays obtusely pointed.

The marginal range consists of somewhat quadrangular plates, having a width a little greater than the length; the first eight of these have a length of ½ inch, and there are about eighteen in the length of an inch, and not far from twenty-five in each range, though the specimen does not permit us to make the count with certainty. The surface is strongly tubercular, and was probably spinous.

The adambulacral range consists of about twenty-eight plates, on each side of a ray; they are narrower than the marginal plates, but have about the same length. Each plate bore strong spines, and some of them, preserved on our specimen, have a length greater than the length of a plate. A single, somewhat pentagonal or irregular axillary plate, rests between the terminal marginal plates and the angle formed by the junction of the adambulacral plates. The extension of the wedge-shaped marginal plates into this angle is by gaping, and the axillary plate seems to fill this gape and to rest upon the extension of the marginal plates, supported by four adambulacral plates, which abut against it.

The ambulacral plates have their greatest length across the rays, thus providing a wide ambulacral furrow. Each plate is furnished with a sharp ridge in the middle, that curves slightly outward, from the center toward the adambulacral range, increasing in height, until it approaches or abuts against the adambulacral plate. The plates have a length in the direction of the rays one half greater than in *P. granulosus*, the ridge is higher and stronger, and occupies the central part of the plate, instead of commencing at the outer posterior angle, and terminating on the anterior inner angle of one plate, and reversing this direction on the next adjoining plate, as in *P. granulosus*. The character of these plates alone will, therefore, serve to distinguish

this species from *P. granulosus*, and other species having about the same size and general outline. The appearance of having been carved out, which is presented by the ambulacral plates, suggested the specific name.

The dorsal side and madreporiform tubercle unknown.

This species is founded upon a single specimen, from the upper part of the Hudson River Group, near Waynesville, Ohio, and is from the collection of I. H. Harris, Esq., of that place.

CYCLOCYSTOIDES MAGNUS.

Plate I., fig. 2, natural size; fig. 2*a*, magnified two diameters.

Cyclocystoides magnus, Miller and Dyer, 1878, JOUR. OF CIN. SOC. OF NAT. HIST., vol. i., p. 32, pl. II., figs. 8, 8*a*.

The specimen of this species now before me has been worn upon the surface, and much of the plates composing the ring has been rubbed off, and three of the plates have been entirely removed; but, otherwise, it is much better than any I had seen, at the time, of establishing the species; indeed, it is the only specimen in this genus, that I have ever seen, from which one could gather any idea of the central part of the disc or body. In comparing the original illustration with that now given, one must bear in mind, that the inner part of the rim of the specimen now illustrated has been worn down to the level of the outer rim, and the scars or mammillary elevations are scarcely discernible, though enough can be detected to show the double character of the plates forming the ring, and to leave no doubt of the correctness of the specific identification.

The ring that surrounds the disc is composed of twenty plates, arranged, with reference to their length and connection with the central part, into ten pairs. Two of the shorter plates, each having two radiating channels toward the central part of the disc, are followed by two of the longer plates, each of which is possessed of three radiating channels. This arrangement furnishes fifty channels connecting the ring with the radiate system of the disc; but the two channels from one of the shorter plates, unite with the three channels of the adjoining longer plate, before reaching the central part of the disc, and, at this part of the disc, the channels are, therefore, reduced to ten. The central part of the disc of our specimen is too much injured for us to follow this system nearer to the center. The injury is apparent in fig. 2, but in the magnified view, fig. 2*a*, the injury is patched up by the erroneous substitution of plates. Whether, therefore, the central part of the disc was connected with the ring by ten channels, which increased, by bifurcation, as they approached the ring

to fifty, or whether the ten channels were reduced to five before they united at the center, as seems quite probable, we are unable to determine. The whole disc within the ring was covered with plates that seem to have imbricated toward the center, and the condition of the preservation of our specimen is such that the series of radiating channels appear to have inosculated, but whether this appearance has resulted from the erosion of part of the imbricating plates, or really represents the true character of the radiating circulation of the animal, is not fully determined.

It would seem probable, from what we know of this species, that it consisted of a central disc, which was covered by numerous small plates and surrounded by a rim composed of twenty-plates, which bore upon its outer surface another rim or border having as many or more scars, or mammillary elevations upon it, as there were circulating channels connecting it with the disc. That from the central part of the disc, there arose either five or ten radiating channels, which bifurcated and possibly inosculated and pierced the rim in fifty places. That the circulation passed through the rim into the outer border. That the scars upon the outer border represent the cicatrices of ossicula. That there was a circular circulation through the rim, and as the rim is tuberculous, there may have been a porous connection with the outer world through it.

The specimen illustrated is from the collection of I. H. Harris, Esq., of Waynesville, Ohio, and was found in the upper part of the Hudson River Group, in that locality.

Xenocrinus, n. gen.

[Ety.—*Xenos*, strange, new; *krinon*, a lily.]

Body, proportionally, rather long and gently expanding, so that its diameter, at the free arms, is only one half or two thirds of its length.

Basals, four; no subradials; primary radials three; secondary radials four, five, six, or more, which enter into and form part of the cup or body; interradial and inter-secondary radial areas deeply excavated and filled by numerous small plates; azygous interradial area containing a vertical series of plates, to the top of the body, of about the same size as the radial plates, which rest upon a basal plate and occupy the central part of the azygous area, and between which and the primary and secondary radials, on either side, there is an excavated area filled by numerous small plates, as in the four regular interradial areas. The vertical series, however, continues to the top of the proboscis, which is prolonged to or beyond the extension of the arms.

Arms, ten; pinnulæ, long, quite in contact, and some of the lower ones appearing to become incorporated into the body or cup; column, quadrangular.

XENOCRINUS PENICILLUS, n. sp.

Plate I., fig. 3, natural size, showing azygous side; fig. 3*a*, same specimen magnified two diameters; fig. 3*b*, magnified view of the azygous side of a compressed specimen; fig. 3*c*, view of the posterior side of a specimen, showing the arms and pinnulæ, magnified about half its diameter.

Basals.—Basals, four, uniting at the angles of the column, about twice as wide as high, two of them are hexagonal and the other two pentagonal. The surface is granulous.

Primary radials.—Primary radials, three, in each series, about twice as long as wide; each series forming a convex, elevated ridge, contracted at the point of the union of the plates; four of the series are supported in the angles, formed at the junction of the basal plates, and the fifth or posterior series is supported upon the middle of the basal plate opposite the azygous side. The plates have about the same length. The third-primary radials are a little wider in the upper part than the others, and support upon the two superior sides the secondary radial series.

Secondary radials.—The secondary radial or brachial series is continued into the free arms, the first plate has a length about equal to that of a primary radial, the second plate is a little shorter, the third plate about two thirds as long, the fourth plate about half the length, or a little wider than high, the fifth plate about one third the length, and the sixth plate has a length about equal to one half its width. Above this the plates become shorter, without any noticeable contraction of the width, until the arms are wholly free from the vault, the plates are then cuneiform, and the width is equal to the length of about three plates.

Interradial and inter-secondary radial spaces.—These long, narrow, depressed areas are covered with small plates, having a tubercle or short spine in the central part of each. There are more than seventy-five plates in each interradial area, and twenty-five or more in each inter-secondary radial area before reaching the top of the cup, but the small plates continue over the margin of the vault, and undoubtedly cover it, and also more or less of the long proboscis, which is extended from the anterior or azygous side.

Azygous area.—The azygous area is remarkably large, and covered, in the central part, by a vertical series of plates having about the same size as the regular radial series; and upon each side of the vertical series, there is a depressed area covered by small plates, having a

tubercle, in the central part, as in the regular interradial areas. There are seven plates, each having a length about twice as great as its width, in the vertical series, from the basal plate, upon which the series rests to the top of the vault. This vertical series is continued to the top of the proboscis, and contains in its entire length more than fourteen plates. It has such strong resemblance to the radial series, except as to the branching at the secondary radials, that the general appearance of the body is that of a species having six radial series.

Arms and pinnulæ.—There are ten arms composed of cuneiform plates, the length of three of which is about equal to the diameter of an arm. The pinnulæ are comparatively coarse, and hence form a dense fringe, upon each side of an arm ; they are long and composed of more than a dozen plates. Some of the lower pinnulæ appear to be incorporated into the general body, an appearance noticed in *Glyptocrinus nealli*, by Prof. Meek, and in *G. richardsoni*, by Prof. Wetherby.

Column.—The column is quadrangular at the head, but possibly round below. It is perforated at the center by a small, round orifice. The face of each plate contains a central square body, having a diameter equal to about half the diameter of the column, which is surrounded by a quadrijugous, serrated line, having the angles extended, and the sides depressed or concave, and which in its turn is surrounded by a smooth, quadrangular margin having concave sides.

The genus and species were first studied from two specimens, illustrated by figs. 3, 3*a*, and 3*b*, from the collection of I. H. Harris, Esq., of Waynesville. Ohio, and which were found in the Hudson River Group of that locality. Subsequently I received a specimen for examination, from Dr. D. T. D. Dyche, of Lebanon, Ohio, which shows the azygous side and fourteen plates of the vertical series. From this specimen we learn that the proboscis extends as high as, and probably beyond, the extremity of the arms. And later I received from the collection of Dr. S. S. Scoville, of Lebanon, the specimen illustrated by figure 3*c*, which shows very well the character of the pinnulæ. As the species has been collected at two or three different places, in the upper part of the Hudson River Group, in Warren county, and the quadrangular columns are not uncommon, at the same range, in Indiana, the species may not be so rare as we have been led, hitherto, to suppose. The square column, which I described in the Cincinnati *Quarterly Journal of Science*, in 1875, and which changes to a round column a few inches below the head, does not, probably, belong to this species. For years collectors have sought for the head belonging to

the square column, but it was not found until during the past year, and now we have not only two species, but they belong to distinct genera.

Glyptocrinus harrisi, n. sp.

Plate I., fig. 4, azygous side, natural size; fig. 4*a*, same, magnified two diameters.

General form of the body, obconoidal, with slightly depressed interradial and axillary areas, as in *G. decadactylus.* I have not been able to determine with certainty, whether this species has four or five basal plates, but as in all other respects it agrees with *Glyptocrinus*, I suppose it possesses five, each of which is wider than high. If, however, it possesses only four, it would not belong to *Xenocrinus*, above established, but would still be very closely allied to *Glyptocrinus.*

There are three primary radials in each series. These plates are heptagonal or hexagonal, and of about equal size, as in *G. decadactylus.* The third primary radial supports upon its upper sloping sides, the secondary radials of which there are two in each series, as in *G. decadactylus.* From the second of these there arises the two series of brachial plates, the first seven or eight of which are incorporated into and form part of the body. Here the species may be easily distinguished from *G. decadactylus*, for, in the latter, only one or two plates are incorporated into the body. The increased number of brachial plates in the body, at this place, makes it very much longer, proportionally, than *G. decadactylus.*

There are twenty free arms at the vault, but whether they bifurcate above this or not has not been determined. The interradial series consists of one plate in the first range, and two in the second, as in *G. decadactylus*; but above this there are many more plates, owing to the increased length of the body, than there are in the latter species. The azygous area is distinguished from that of *G. decadactylus*, by the increased extension. The axillary areas contain twenty or thirty small plates having a central tubercle on each; and the interbrachial areas have not less than ten or fifteen similar plates in each area. The surface is sculptured, in the lower part of the body, so as to form triangular depressions between the six star-like radiations from the central part of the plates, as in *G. decadactylus*; but, above the primary radials, the plates are simply tubercled, and above the secondary radials not more than a single tubercle occurs on each plate.

The column is square, and it is highly probable that the square crinoid column, that I described in the *Cincinnati Quarterly Journal of Science*, in 1875, belongs to this species.

The species is founded upon a single specimen, from the collection of I. H. Harris, Esq., of Waynesville, Ohio, in whose honor I have proposed the specific name. It was found in the upper part of the Hudson River Group, at that locality.

GLYPTOCRINUS COGNATUS, n. sp.

Plate I., fig. 5, view of the lower part of the body, natural size; fig, 5*a*, side view, natural size.

Body, turbinate; strongly pentagonal in outline, as viewed from below; height about equal to the width. There are five sub-basal plates, having a height at the superior angle, in the middle, nearly equal to one half the width of a plate. There are five comparatively large, heptagonal, basal plates, about as wide as high, depressed at the line of junction, and elevated in the central part, thus forming a sub-pentagonal outline for this part of the cup. These plates, each, rest upon two of the sub-basals, support upon the upper sloping sides the radials, and upon the superior face an interradial.

The first primary radial is heptagonal, about as wide as high, and a little larger than either of the others; the second and third are hexagonal, and a little higher than wide; the three form a convex, elevated ridge, which gives to the body a strong, pentagonal outline, when viewed from below. The third supports upon its upper sloping sides the secondary radials, and upon its superior face an axillary or intersecondary radial plate. Not less than eight of the secondary radials or brachial series enter into and form part of the body. They gradually diminish in length, so that at about the eighth plate the arms become free.

Regular interradial areas deeply excavated, and occupied by about forty plates, and axillary areas also deeply excavated, and occupied by about twenty plates.

The species is established upon a specimen found in the upper part of the Hudson River Group, near Middletown, Ohio, and now in the collection of Dr. R. M. Byrnes, of Cincinnati. The azygous area and character of the arms, unknown.

It has a close relationship with *Glyptocrinus nealli*, though it is distinguished by having larger plates, and only about half as many in the interradial and axillary areas. The sub-basals are developed so they might be properly called basals, and thus remove the species from the genus *Glyptocrinus*. I have called it *cognatus*, from its being near a kin to the *nealli*, and by some it may be regarded as only a variety, but comparing it with the specimens in my own collection, I am in-

clined to think it is sufficiently distinct to have a specific name. The interradial and axillary plates may have each contained a central tubercle or spine, but our specimen is not in such a state of preservation as to determine this.

STROTOCRINUS BLOOMFIELDENSIS.

Plate I., fig. 6, natural size, but the underside of the canopy should be dropped down to the dotted lines.

(*Strotocrinus bloomfieldensis*, S. A. Miller, 1879, JOUR. CIN. SOC. NAT. HIST., vol. ii., p. 258, pl. XV., figs. 6, 6*a*.)

This species was originally founded upon a cast, but later I received from W. C. Egan, of Chicago, the matrix, from which a gutta percha cast was taken, and by this means we have the surface marking of the plates completely restored, and are enabled to add to the description.

The third radial is octagonal, instead of heptagonal, having a short superior face, upon which an inter-axillary plate is supported.

The species most resembles *S. regalis*, from which it is, however, readily distinguished, by its much shorter first radials, by the octagonal third radials, instead of heptagonal, by the presence of the subcentral proboscis, and by numerous minor differences. The ornamentation of the plates, too, is different, though there is great similarity between them, in this respect. It need not be compared with any other known species.

ORTHODESMA BYRNESI, n. sp.

Plate I., fig. 7, view of the left valve, natural size; fig. 7*a*, cardinal view, natural size; fig. 7*b*, magnified view of the matrix, showing that the shell was covered by numerous little spines.

Shell of medium length and breadth, but proportionally very thin. Cardinal and basal margins sub-parallel, but gradually diverging posteriorly to the posterior third of the shell. The cardinal line is straight, posterior to the beaks, for about one third of the length of the shell, from which point it gradually declines to near the extremity, which is abruptly rounded. Anterior end contracted beneath the beaks, and beautifully rounded in front. Basal line concave in the middle part, for about one half the length. Beaks small, but nearly or quite uniting; umbones flattened, and, from which, there is a shallow expanding depression, directed a little posteriorly, and crossing the valves to the basal line.

Surface of the valves marked by concentric lines, and covered by numerous little spines.

Length, 1 2-10 inches; height, 5-10 inch; thickness, 25-100 inch.

The species is founded upon a specimen preserving the shell, and

also upon the matrix from which the shell was taken, collected by Dr. R. M. Byrnes, in whose honor I have given the specific name, in the upper part of the Hudson River Group, near Weisburg, Indiana, and now belonging to his collection. It is peculiar in preserving the markings of the spines which covered the surface, in the matrix, and also preserving the bases of them on the shell, which may be readily observed with an ordinary magnifier. It will be distinguished from other species by the fact that its thickness is only half its height, and only one fifth its length, as well as by other peculiarities. As this species was covered with numerous spines, it becomes interesting to know whether other species in the same genus were also thus ornamented.

DESCRIPTION OF NEW FOSSILS FROM THE LOWER SILURIAN AND SUBCARBONIFEROUS ROCKS OF OHIO AND KENTUCKY. *

By A. G. Wetherby, A. M.,

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CEPHALOPODA.

Colpoceras, Hall, 1850, 3d Reg. Rep., N. Y., Birdseye and Black river.

Colpoceras clarkei, nov. sp. (Plate II., figs. 5, 5*a*.)

Shell very gradually tapering, composed of equal septa, obliquely united at the sides, with a gently rounded convexity pointing to the posterior extremity on the dorsal surface, fig. 5, Pl. II., and an acute angle pointing toward the body chamber on the ventral surface, fig. 5*a*, Pl. II. The septa are separated by slight semi-sutures, which give the shell a somewhat corrugated appearance, as may be seen in the figures. The obliquity of their line of junction throws the point of the ventral angle of each segment more than three times the width of the segment itself, in front of its posterior dorsal margin. The septa in the specimen figured have a width of 9 mm.

In section the specimen is seen to be slightly elliptical, owing to the shortening of the dorso-ventral diameter, which measures 20 mm., while the transverse measures 23½ mm. Nine segments of the shell measure two and one half inches, 62½ mm., in length, with an almost

imperceptible difference, $1\frac{1}{2}$ mm., in the diameter of the two extremities. Although the specimens are in an elegant state of preservation, so far as the outside marking is concerned, they are silicified, and no evidences of the siphuncle remain.

Remarks.—As this is the second species of this remarkable genus, considerable interest attaches to its discovery. It occurs with the species of *Amygdalocystites, Hybocystites, Comarocystites, Apiocystites* (*?*), *Porocrinus, Hybocrinus, Palæocrinus, Blastoidocrinus, Carabocrinus, Edrioaster* (?), etc., which I have discovered in the Trenton rocks of Mercer county, Kentucky.

I have found four specimens, one of which is three times the dimensions of the type herewith figured, and is, no doubt, a different species.

I dedicate this rare fossil to my friend, Robert Clarke, Esq., who has assisted me in my labors by the generous donation of his large collection of shells, minerals, and fossils, to the University Museum, and also by the use of rare books from his extensive palæontological library, as well as by the warm interest he has always taken in my studies.

CYRTOCERAS Goldfuss, 1832.

CYRTOCERAS CONOIDALE, nov. sp. (Plate II., figs. 6, 6*a*.)

Shell very rapidly tapering, consisting of numerous short septa, of equal length. The specimens which I regard as typical, fig. 6*a*, Pl. II., have a comparatively slight curvature. There are seventeen septa in a length of one inch. The siphuncle is small and dorsal. The shell appears to have been exceptionally fragile, as all the specimens which I have seen, except one from the Tennessee locality, are very much distorted by pressure.

Remarks.—I collected this fossil in August, 1877, at "Mt. Parnassus," Columbia, Maury county, Tennessee; in 1879, at McKinney's station, on the C. S. R.R., Boyle county, Kentucky; and have since received it from my friend, Mr. W. M. Linney, of Harrodsburg, Kentucky, who collected it in Garrard county. At Columbia it was associated with *Stellipora autheloidea*, *O. lynx*, and *Crania scabiosa*, on the old redoubt excavation of "Mt. Parnassus;" at McKinney's. I collected with it *Streptorhynchus filitextus*, *Ptilodictya hilli*, *Murchisonia bellicincta*, and undetermined corals, evidently belonging to the Cincinnati Group. At the Garrard county locality, it occurs with *P. hilli*, and a *Rhynchonella*, probably a variety of *R. capax*.

It has been confounded with the *C. vallandinghami*, S. A. Miller, from which it is entirely distinct. The body chamber being wanting in all the specimens, the diameter can not be determined. I regard the specimen, fig. 6, Pl. II., as a different species, and nearly allied to *C. vallandinghami*, S. A. Miller.

CYRTOCERAS IRREGULARE, nov. sp. (Plate II., fig. 3).

Shell composed of short segments, nearly equal in length and size in the anterior third, gradually becoming shorter and smaller in the posterior two thirds. It is moderately curved, the curvature not being well shown in the figure, which is a dorsal view. The specimen is slightly distorted by pressure, but evidences remain that it was somewhat elliptical in section from the shortening of the dorso-ventral diameter.

The irregularities of form, which are well shown in the figure, characterized, likewise, a specimen once shown to me at the University, by the veteran palæontologist, C. B. Dyer, Esq., and which I instantly recognized as being this species. These two specimens are the only ones that have fallen under my observation. The siphuncle is dorsal and comparatively large.

The specimen figured, which has a small portion of the body chamber, consists of twenty-four septa, and measures 55 mm. in length. The body chamber measures 24 mm. in its greatest, and 11. mm. in its least diameter. The opposite extremity measures 8 mm. and 5 mm. in the same diameters, respectively. I collected this species in May, 1877, at Freeport, Warren county, Ohio, in the upper part of the Cincinnati Group. It appears to be rare.

Genus TREMATODISCUS, Meek and Worthen, 1861, Proc. Acad. Nat. Sci., Phil.

TREMATODISCUS KONINCKI, nov. sp. (Plate II., fig. 4.)

Shell consisting of about three coils, formed of about sixty septa, and a part of the body-chamber, measuring 38 mm. in length, on the outer convexity.

The septa, as may be seen in the figure, are joined by slightly waved sutures, which have, also, a small dorsal flexure. They are longer on the dorsal than on the ventral side, presenting a somewhat wedge-shaped appearance as shown by the figure. The five septa immediately following the body-chamber are 6 mm. in length on the dorsal surface.

They are evidently not more than half this on the inner side. They decrease constantly but rapidly in size and length, so that the shell tapers regularly to the apex of the coils. The whole surface is fluted with parallel coarse striæ, obliterated in the type, evidently markings of the shell ornamentation, as indicated by other fragments of the same species. The shell was exceedingly thin and fragile. Its markings are most pronounced on that part of the cast which filled the body-chamber. In transverse section this cavity was nearly circular. Diameter of the specimen, measured across from outside of body-chamber, 56 mm., of body-chamber at mouth, as preserved, 20 mm.

I collected this fine species, as represented by the type, and several fragments, in the subcarboniferous rocks of the lower Waverly, at King's Mountain Tunnel, on the C. S. R. R.

It was there associated with another, much larger and coarser species, and with fossils belonging both to the Kinderhook and Keokuk Groups. A fuller study of this part of the subcarboniferous rocks of Kentucky, and more extensive collections of its fossils, which are abundant and well preserved, is very much needed. I hope to make further explorations in this region during the coming spring and summer, and hence assign no closer geological limits to the horizon of this fossil for the present. I take great pleasure in dedicating this species to my valued correspondent, Dr. L. de Koninck, of Liege, Belgium, who has done more to develop a scientific and accurate knowledge of the carboniferous fossils of Europe than any other student of its geology.

CRUSTACEA.

Isochilina, Jones, 1858, Can. Org. Rem., Dec. 3.

Isochilina jonesi, nov. sp. (Plate II., figs. 7, 7*a.*)

General Description.

"Equivalve, the margins of the valves meeting uniformly, not overlapping as in *Leperditia;* greatest convexity of the valves, either central or toward the anterior portion. Eye-tubercle present. Muscular spot not distinct externally." Carapace having much the size and shape of the *Leperditia baltica;* dorsal margin straight, ventral gently curved. Anterior and posterior margins, rounded. Marginal border very wide at the posterior extremity of the valves, narrowing much anteriorly in the inferior margin, at the center, and widening again, somewhat, at the anterior side. Valves very convex, with the greatest elevation as seen in profile, sub-central, near to the anterior,

dorsal margin. Eye-tubercle very distinct. Muscular spot well indicated. Length of medium sized specimen, 22 mm., breadth, 14 mm., greatest convexity 6 mm., width of margin on posterior border, $3\frac{1}{2}$ mm. This beautiful fossil occurs in great numbers, and in high perfection, associated with other species of bivalve crustacea, at a single locality in the Trenton limestone of Mercer county, Kentucky. I have dedicated the species to my esteemed correspondent, Prof. T. Rupert Jones, F. R. S., F. G. S., etc., who regards *Isochilina* as a sub-genus under *Leperditia.*

Proetus, Steininger, 1830.

Proetus granulatus, nov. sp. (Plate II., figs. 8, 8*a*, 9, 9*a.*)

Body.—General form elongate elliptical, the cephalic, thoracic and abdominal region being nearly equal in length, the thoracic slightly shorter.

Head.—Rounded in front, the angles of the cheeks produced backward into short, heavy spines; *glabella* very prominent, slightly constricted near the center, surface granulated, lobed posteriorly; occipital furrow well defined; cheeks margined, the margined space longitudinally striated, and much narrowed in front of the glabella; eyes prominent, separate from the glabella by a deep groove; entire surface of the head minutely granulate.

Thorax.—Consisting of ten (?) segments; *axial lobe* very prominent, about equal in width to the lateral lobes, the segments slightly arched forward in the middle, nearly or quite equal in length; *lateral lobes* about as wide as the central, geniculate, with the extremities of the pleura directed backward.

Pygidium.—Semi-elliptical, consisting of fifteen (?) segments, *axial lobe*, prominent, narrower than the lateral lobes, segments not arched, gradually tapering backward to the margin; *lateral lobes* wider in front, tapering posteriorly, widely margined, the margin continuous and granulated. Length of medium-sized specimen, 20 mm.; width across from tip to tip of spines, 10 mm.; length of largest specimen, 26 mm. This may be a different species, but the materials in hand are not sufficient to determine with certainty. This species is not closely enough allied to any hitherto described from American rocks, to make any comparison necessary. It somewhat resembles *P. stokesi*, Murchison, of the Niagara Group, but is sufficiently distinct, both specifically and stratigraphically.

It is worthy of remark that I have found specimens of this trilobite,

and of an undetermined Phillipsia, in fossil bodies which I suppose to be the coprolites of the large fishes inhabiting the same seas, and of the magnificently preserved teeth of which I have collected a very large series. I have found, in these bodies, remains of *Pentremites*, corals, casts of small bivalve molluscs, axes of *Archimedes*, and small univalves.

These fishes evidently browsed upon the Bryozoa, and did not disdain an occasional crustacean and molluscan morsel.

I collected these trilobites in the Kaskaskia (Chester) Group, subcarboniferous, Pulaski county, Ky.

ECHINODERMA.

Genus Heterocrinus, Hall, 1847, Pal. N. Y., vol. i.

Heterocrinus vaupeli, nov. sp. (Plate II., figs. 1, 1*a*.)

Of this remarkable species we have but a single imperfect specimen, consisting of the middle third of the rays. No part of the body, column, or upper part of the arms has been seen.

The plan of the species is very much like that of *H. constrictus*, Hall. The arms are comparatively heavy, ten in number, and composed of plates which are slightly longer than wide, but so nearly equal in these two dimensions as to give them a very regularly quadrate form. At the sutures joining the plates, as may be seen in fig. 1*a*, Pl. II., there are ridges running across the arms, which join lateral ones belonging to the arms themselves. As these elevations are raised above the general surface of the arms, about one third the thickness of the latter, the effect is to give the crinoid a beautifully reticulated appearance, well shown in the figure. In several very perfect specimens of the *H. constrictus*, which I have studied, the "armlets" (Meek, Ohio Pal., vol. i., p. 3), subdivided on the second, third or fourth piece, the place of the division being somewhat irregular in the upper part of the arms. In this species there are no subdivision of the armlets, which are much more delicate than those of the *H. constrictus.* The method of origin of the armlets is nearly alike in the two species, so far as can be determined by the specimen. In *H. vaupeli* the armlets are long and gradually tapering to the extremity.

There are no evidences of ordinary pinnulæ. As this is also the case in the *H. constrictus*, so far as I have been able to determine from very perfect specimens, I am of the opinion that these two species should be set aside as very distinct from *Heterocrinus* proper. The

origin of the armlets, the absence of true pinnulæ, and the presence of a long proboscis, are characters very different from those belonging to the *H. simplex*, which may be regarded as the type of the genus.

I dedicate this beautiful and unique fossil to its discoverer, Mr. Ernst H. Vaupel, of this city, who has collected many of our rarest fossils, and who is devoting especial attention to our corals.

Genus Reteocrinus, Billings, 1858, Can. Org. Rem., Dec. 4.

Under this generic name, Mr. Billings described two species from the Trenton rocks of Canada, in the publication cited above. Like most of the fossils of the locality whence they were obtained, these were in a very poor state of preservation. Enough is shown, however, by Mr. Billings' figures, to make it conclusive that several forms of our so called *Glyptocrinus* should be referred to this genus. Among them I should place *G. nealli*, Hall, *G. richardsoni*, Wetherby, and the species of which the description is to follow. Not wishing, however, to be too hasty, I now include, under *Reteocrinus*, only *R. richardsoni* and *R. gracilis.* I may add, in order to give authority to this determination, that the same opinion is held by Mr. Wachsmuth, of Burlington, Iowa, who will so group these species in his forthcoming volume on the *Paleocrinoidea.*

Reteocrinus gracilis, nov. sp. (Plate II., fig. 2*a*, azygous; 2, opposite side).

Underbasals.—Five, very small, nearly concealed between the column and the greatly developed basals. In the size of these plates this species agrees with *R. nealli.*

Basals—Five, hexagonal, somewhat higher than wide, squarely truncated above, and here forming the base of the interradial space. The outer angles of the upper extremity are cut off, forming the articular surface for the support of the first radials. From the lateral angles thus formed near the center of these plates, they narrow gradually to the lower extremity which is rounded. The widest part of the plates is at this lateral angle, so that the basals do not join at the sides below this point, leaving a suture through which the minute underbasals and the top of the column may be seen, and over which the center of the first radials rests. The basals are thick and heavy plates, the one on the azygous side being slightly wider and shorter than either of the other four.

Radials—First series, five, pentagonal, higher than wide, squarely

truncated above, the sloping inferior sides resting between the basals. The lowest point of these plates, which is on a line with the suture joining the basals, is slightly excavated, giving the lower end a bifurcate appearance. The interradial sides are depressed, leaving an elevated central ridge to this part of the ray which is thus continued throughout the radial and brachial series.

Second radials—Five, quadrangular, higher than wide, equal in size, squarely truncated above and below, lateral margins depressed.

Third radials—Five, pentagonal, higher than wide, wider above, with two articulating surfaces upon which the rays divide. Lateral edges depressed into the borders of the interradial spaces, upper margin slightly excavated between the articulating faces, giving the plate a bifurcate appearance.

Brachials—First series, ten, quadrangular, higher than wide, equal in size, and alike in form. Second series, ten, pentagonal, higher than wide, wider above, with two articular facets, upon each of which an arm originates, a slight excavation occupying the space between these facets.

Arms—Twenty, long, slender, composed of equal, quadrangular plates, about as high as wide, without bifurcation or divisions.

Pinnulæ—Long, delicate, and originating on alternate arm plates either side of the ambulacral groove.

Vault—Unknown.

Anal and interradial spaces filled by an indefinite number of small, delicate, generally hexagonal plates. Among these may be detected those of the "fixed pinnulæ," to which I called attention in my description of *Reteocrinus richardsoni.*

I have great pleasure in again acknowledging the high character of the work done by Mr. Billings, whose keen discrimination detected the generic value of the imperfectly preserved specimens with which he had to deal. This beautiful fossil was discovered in Lime Kiln Hollow, formerly a noted collecting ground, by Ernst H. Vaupel and Mr. John Nickles, to whose kindness I owe this opportunity of describing it.

Note on the Trenton Fossils of Mercer Co., Ky.

Since publishing my article on the Trenton Limestone of Kentucky (this Journal, July, 1880), I have discovered many rare additional forms. Among them must be noted a large species of *Comarocystites;*

several species of Crinoids, as yet unstudied; a fine specimen of *Ateleocystites* (?) and several very fine trilobites. When it is remembered that two years since nothing was known of the fossil contents of these massive Kentucky river limestones, it is gratifying to be able to record such progress, in working out the evidences of their age as determined by their fossils. Much, however, remains to be done in reference to the lower part of the section, which proves to be full of fossils, though the localities containing well preserved specimens are very few. It is quite certain, however, that the lowest part of the section at High Bridge is either very low Trenton or even Chazy.

During the present season I hope to accomplish such discoveries of fossils as will determine this question satisfactorily. The new life which the Kentucky Geological Survey has, under its present competent Chief Geologist, Hon. John R. Procter, will, I am sure, add much to the facilitating of this work.

REPORT OF THE COMMITTEE ON THE LIFE AND CHARACTER OF GEORGE GRAHAM.

The committee appointed at the last regular meeting of the Cincinnati Society of Natural History, to prepare a notice of the life of Mr. George Graham, a prominent citizen of Cincinnati, and a life member of this Society—begs leave respectfully to report:

That Geo. Graham, who died March 1st, 1881, in the 83d year of his age, was born at Stoyestown, Somerset county, Pennsylvania, in November, 1798; that he was the son of George and Elizabeth Graham; and that his father was an officer in the Pennsylvania Volunteers, in the War of 1812. The son accompanied his father when he marched a regiment to the defense of Black Rock in Canada, acting as clerk and making out payrolls. On his return from this expedition he went into the dry goods business with his brother; but in 1816 we find they had contracted to build the first turnpike road over the Alleghany mountains, and agreed to haul merchandise from Philadelphia to Pittsburg in ten days. Thus, at the early age of 18 years, we find him engaged in those public enterprises which introduced a life of usefulness, as his subsequent career will show.

In 1822, he came to Cincinnati, at that time a comparatively small frontier settlement; and from that time until his death he was an active and useful citizen. On his arrival here he entered into partnership

with M. P. Cassilly, and George M. Davis, and engaged in the hardware business. This partnership lasted but three months, when, in consequence of some disagreement, Mr. Graham retired from the firm. His next venture was to supply troops at Prairie du Chien and Fort Snelling with army supplies. In 1823, he returned to Cincinnati, and formed a partnership with C. W. Gazzam, and engaged in the commission and steamboat business, the firm acting also as agents and builders of boats in the Cincinnati and New Orleans trade.

He was a leading Mason, and was one of the charter members for the organization of the LaFayette Lodge, to receive the distinguished foreigner, Marquis de LaFayette; and when, in 1825, the illustrious Frenchman came to Cincinnati, Mr. Graham delivered the welcoming address; and in 1827 he took the 33d degree of the Scottish Rite, and was one of seven who organized the Scottish Rite Consistory in Ohio, now numbering 700 members.

In May, 1817, Mr. Samuel W. Davis obtained from the Legislature of Ohio, a charter to supply the city of Cincinnati with water for 100 years. He was, however, unable to keep to his contract, and in 1825 offered to sell to the city his charter, and ten acres of ground with improvements for $20,000. The offer was rejected. Mr. Graham with a far sightedness, remarkable in a young man of 27, saw the importance of the project to the city, and with John P. Foote, Wm. Green, Davis B. Lawler, and Wm. S. Johnston, purchased what the city had refused, for $30,000. Five times during the next fourteen years, the city desired a price to be set upon the works, and in 1839 purchased them for $300,000, just ten times the original cost.

In 1827, Mr. Graham was married to Miss Ellen F. Murdoch, of Urbana, Ohio. He had five children by the marriage, only two of whom are now living, Mr. Robt. M. Graham, and Lavinia M., the wife of Mr. John M. Newton, Librarian of the Young Men's Mercantile Library Association.

In 1829, he was elected to the Legislature, and while there, as chairman of the Finance Committee, detected and rectified abuses and frauds which had existed for some years.

In 1829, he, in connection with A. Richards, was the owner of the first cotton mill in Dayton, Ohio, and of the first carpet factory west of the Alleghany mountains. At the same time he carried on a foundry for making cotton mills and other machinery. In 1835 he made a contract with some Mexican capitalists, to build and put into operation machinery for making fine cambric muslins in the Durango

District in Mexico, 900 miles from the sea coast. This machinery had to be made in pieces of about 100 pounds, in order to be transported over the mountains on the backs of mules.

In 1832, Mr. Graham was elected trustee of the public schools; and as such made many needed reforms, and introduced new regulations. He constructed rules for the government of schools, teachers, and scholars. These were printed, framed, and hung up in every school house. He introduced the system of school examinations, and used to march at the head of the procession of children through the streets on the last day of school, to some church where rewards of merit were distributed by the mayor.

In 1834, he applied to the city government for funds to build a model brick school house for 500 pupils. The council had proposed to erect a wooden house of two stories for $1,200. This did not suit Mr. Graham, who said he did not wish to see the scholars burned to death in a frame building. Following his own ideas, he appointed an architect to erect a brick school house, and guaranteed payment in case the city refused. The building was completed in 1834, afterward remodeled and enlarged, and still stands on Race street, opposite the Arcade, devoted to other than educational purposes. Eight other school houses were soon erected in various wards of the city, by money procured on bonds, payable 25 years from date. About the same time, he, with John P. Foote and Calvin Fletcher, organized the Mechanics' Institute. For several years the three paid the rent of a building suitable for the purpose.

In 1836, Mr. Graham and other citizens fitted out a body of troops, and sent them to Texas to defend it from the threatened invasion of Santa Anna. These troops, with a regiment from Louisville, comprised the main part of the army which fought at San Jacinto under Generals Sherman and Houston; the army captured Santa Anna, thus securing the independence of Texas.

In 1838, he was elected President of the Jeffersonville Association, which was organized in 1836, to build a canal around the Falls on the Indiana side of the Ohio. Five hundred and forty acres of land were laid off in lots. Surveys were made by the company and by Col. Long, U. S. engineer; and from these surveys it was estimated that for $1,800,000 a canal 60 to 80 feet wide, with locks 400 feet in length, to pass the largest boats, could be built. This was about the amount required to enlarge the Louisville canal. During two sessions of Congress, Mr. Graham was in Washington, and labored hard to get aid for

the passage of a bill for the company. Southern influence was too strong for him, and the bill failed.

He was mainly instrumental in building the Cincinnati and Miamitown, now the Cincinnati and Harrison pike, and macadamized it by means of steam machinery. He also, we believe, was the first to point out that it was possible, by means of gravel alone, to make nearly as good a road as could be made with broken stone.

The Western Academy of Natural Sciences was founded in 1835. Mr. Graham was present at the first called meeting, held at the hall of the Medical society, April 25th of that year. He was one of the committee appointed to prepare a constitution and by-laws, and he was one of those named in the act of incorporation of the academy, Feb. 22, 1836. Afterwards he was, for a number of years, President, in which position he took an active part in all its affairs.* After the formal suspension of the meetings of the academy, and the deposit of its effects in the present Cincinnati Society of Natural History, Mr. Graham was, with several other members of the old organization, elected a life member of the present association. He found time, during the many occupations of a busy life, to make collections of shells, fossils, and plants. These were subsequently destroyed by a fire in a warehouse where they were stored. Up to the time of his death he was constantly on the alert for objects of interest to add to his cabinet.

Cincinnati is acknowledged to be the first city in the United States where steam fire engines were used. When it was announced that the city had such engines, all the other large places in the country ridiculed the idea. It was insisted that nothing better than the old fashioned fire engines could be had. At that time this city possessed a volunteer Fire Department of 3,000 members; and they were governed by laws of their own, and had everything much as they desired. Mr. Graham's early connection with the Water Works, and his active participation in the Fire Department, as chairman of the committee on Finance in the City Council, caused him to suggest the employment of steam fire en-

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* Mr. Graham was the last survivor, but one (Wm. D. Gallagher being now the only one living), who participated in forming the Academy.

Believing it may be of interest to many we append a list of names of those taking part in the organization of the Western Academy of Natural Sciences at Cincinnati, at the first meeting, in the order, and as we find them recorded: R. Buchanan, Dr. Whitman, J. Hall, W. D. Gallagher, Dr. Shotwell, Dr. Colby, Dr. Drake, G. Graham, Dr. Wood, Dr. McDowall, Dr. Gross, Dr. Marshall, Dr. Riddell, J. H. Perkins, Mr. Clark, Dr. Mason, Mr. Eells, J. S. Armstrong, P. Symmes, Dr. Locke, —— Flagg. R. Buchanan acted as Chairman, and J. H. Perkins, as Secretary.

gines. He engaged A. B. and E. Latta to make a machine for an experiment, not to cost more than $400. If successful the city was to purchase the engine. At a public trial, Mr. Miles Greenwood, Mr. Geo. Graham, and Mr. Jos. Ross, officiated as masters of ceremonies. The experiment was a complete success, and the "Bull of the Woods," as it was called, raised steam in five minutes, and threw water a distance of fifty feet from an inch nozzle. At the very next meeting of the council, $5,000 were voted for the purchase of steam fire engines. From the "Bull of the Woods" as a foundation, sprang the present efficient and invaluable system for extinguishing fires.

Mr. Graham was one of the incorporators of the Cincinnati Horticultural society in 1845. Previous to that, he had, in 1844, contributed a paper on "Fire Blight," which appeared in the Proceedings of the Society. He held various offices at different times; was President in 1847, and was re-elected in 1870. He always took an active interest in its proceedings. He was for several years trustee of Woodward and Hughes High Schools, and one of the early trustees of the Cincinnati College, holding that position for forty years.

In 1863, when the Great Western Sanitary Fair was held in this city, Mr. Graham was very active. He was the Chairman of several Committees, and was the chief author and compiler of the 578 page report of the Fair. He personally attended to the unpacking, arranging and labeling of some 1,200 articles exhibited in one of the departments; and much credit is due him for his untiring energy.

In 1867, he visited Europe, spending sometime there, and meeting with various adventures. In 1869, he was one of a congratulatory party which went from Cincinnati to San Francisco when the Pacific railroad was completed. He visited various parts of California, and spent some time in Yosemite valley. A paper written by him, describing the trip, shows Mr. Graham to have been a man of large information, as well as an acute observer.

U. P. JAMES,
A. J. HOWE,
O. D. NORTON, M.D., } *Committee.*

The funeral of Mr. Graham took place from the Church of the New Jerusalem, on the corner of Fourth and John streets, on the 4th of March. The casket was borne to the hearse by John D. Caldwell, L.

J. Cist, Julius Dexter, John Carlisle, Henry Urner, and A. T. Goshorn. He was interred in the Graham lot in Spring Grove.

He has been described as a man of remarkable appearance, having clearly-cut classical features, positive Roman nose, finely-cut mouth, and decisive chin, with the old-time gentleness of manner which would have attracted attention in any country. Here, when strangers or younger persons inquired as to who the remarkable-looking old gentleman might be, they simply learned that it was George Graham, an old citizen. He was identified with or interested in all the recent events that have tended to improve the metropolitan character of the city, and especially in the musical and æsthetical culture. He attended his last Operatic Festival only the Saturday evening before his decease, when, it is supposed, that some slight exposure caused him to contract the indisposition which proved fatal in three days.

He was for many years an active member of the Chamber of Commerce, of this city, and later in life, in compliment of his eminent services in public affairs, in earlier periods, he was elected an honorary life member of that influential body of merchants. The Chamber, in its memorial giving the expression of their members upon his life and character, says :

"Mr. Graham was always a close observer and thinker, a devoted student of nature, and a careful reader of books. He thus acquired a great fund of knowledge, both scientific and practical. He was a man of great general information, and possessed a happy faculty of imparting knowledge to others in a manner fascinating to friends. Even after all active participation of his with enterprises, the efforts of younger men to advance the interests of and build up the city of his adoption, met with his hearty sympathy, as though these efforts were the reflex in his later life of the courage and integrity with which his career was marked in earlier days."

THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. IV. CINCINNATI, JULY, 1881. No. 2.

PROCEEDINGS OF THE SOCIETY.

TUESDAY EVENING, *April* 5, 1881.

Dr. R. M. Byrnes, President, in the chair; L. S. Cotton, Secretary *pro tem.* Present, 28 members.

James R. Challen and R. A. Holden were elected members of the Society.

This being the annual meeting, the Treasurer made his report, showing the funds of the Society, and the income and disbursements of the past year. Other officers of the Society made verbal reports.

The Society elected for the ensuing year the following officers:

President—R. M. Byrnes, M.D.
First Vice-President—J. H. Hunt, M.D.
Second Vice-President—Prof. Ormond Stone.
Secretary—F. W. Langdon, M.D.
Treasurer—S. E. Wright.
Librarian—S. A. Miller.
Curator of Mineralogy—J. W. Hall, Jr.
Palæontology—J. Mickleborough.
Conchology—E. M. Cooper.
Entomology—Harry J. Hunt.
Botany—O. D. Norton, M.D.
Ornithology—J. W. Shorten.
Ichthyology—D. S. Young, M.D.
Archæology—H. H. Hill, M.D.
Comparative Anatomy—A. J. Howe, M.D.
Herpetology—A. E. Heighway, Jr.

Members at large for the Executive Board, Prof. G. W. Harper, C. F. Low, H. H. Hill and J. Mickleborough.

Trustee—R. B. Moore.

A committee consisting of R. B. Moore, U. P. James and Dr. O. D. Norton, was appointed to report suitable expressions of the Society on the death of Mr. David Bowles, a life member.

TUESDAY EVENING, *May* 3, 1881.

Prof. Ormond Stone, Vice-President in the chair; F. W. Langdon, Secretary. Present, 12 members.

H. M. Schultz was elected a member of the Society.

The committee on the Death of Mr. David Bowles was requested to prepare its report in time for publication in the July No. of the JOURNAL.

The Smithsonian Institution presented six volumes of Contributions to Knowledge—vols. 16 to 21 inclusive. Captain L. Barney, vol. 1 of the Proceedings of the Natural History Society of Paris, 1792. E. A. Pohlmeyer an Anaconda, in alcohol. And Joseph F. James some Lepidopterous insects.

TUESDAY EVENING, *June* 7, 1881.

Dr. R. M. Byrnes, President, in the chair; F. W. Langdon, Secretary. Present, 20 members.

Remarks were made by Dr. D. S. Young upon the fossil fish presented by Mr. Charles DeYoung, of California, through the kindness of Mr. Murat Halstead, of the Cincinnati *Commercial.*

Col. P. P. Lane, of Norwood, in Hamilton county, presented to the Society his collection of relics from the ancient cemetery at Madisonville, which embraces several hundred specimens; Dr. C. L. Metz also presented a collection from the same locality; Davis L. James, 33 species of seeds of Cincinnati plants; Dr. A. J. Howe, a Septaria and a Medical Journal; Jos. F. James, 1 box of insects, catalogue of fossils in Heidelberg Mineralogical Institute, and 4 magazines; Mr. E. P. Cranch, an old Cincinnati collector of specimens of Natural History, 22 boxes of fossils, largely from the hills at Cincinnati, 9 boxes of minerals, 6 boxes of shells, some of them quite rare, and 2 boxes of mosses and lichens, and a lot of Pine cones, etc., etc.; Mr. Geo. Skinner, of Kalida, Ohio, a photograph of Indian relics; U. P. James, Paleontologist No. 5; E. H. Vaupel, 42 species of Cincinnati fossils; S. T. Carley, of Bantam, Clermont Co., O., a slab of *Glyptocrinus decadactylus*, and labrum of an *Asaphus*; Charles DeYoung, of San Francisco, California, through Murat Halstead, Esq., a beautiful fossil fish; from Wm. Hubbel Fisher, 2 skins of *Hylotomus pileatus;* and from Dr. O. D. Norton, Michaux's N. Am. Sylva, 3 vols., Browne's Sylva Americana, and Barton's Elements of Botany, 3 vols.

THE CÆNOZOIC AGE OR TERTIARY PERIOD.

By S. A. Miller, Esq.

[*Continued from Vol. iv., page 46.*]

Before reaching Bridger station the strata on either side of the road are horizontal, or nearly so. A long, flat ridge extends down a little east of north from the Uinta mountains, between Black's Fork and the Muddy. This may be regarded as the geological divide between the waters of the Great Salt Lake Basin and the drainage of Green river. The Muddy is one of the branches of Black's Fork, which flows into Green river, and west of this stream we have what is called the eastern rim of the Great Basin of Salt Lake. If we were to travel southward to the foot of the Uinta mountains, from the railroad along this divide, we should be able to detect no well-marked line of separation between the Green River Group and the Wasatch Group. Bridger's Butte, as well as the entire eastern portion of this divide fronting the valley of Black's Fork, exhibits a large thickness of the somber, indurated sands, clays, and sandstones of the Bridger Group, passing down into light buff, chalky layers, with *Planorbis*, *Unio*, *Helix*, *Goniobasis*, etc. Within a distance of ten miles to the west of this butte the little streams cut through the pinkish beds of the Wasatch Group, then pass up into whiter, indurated, marly clays, with numerous concretionary layers, differing from the chalky beds of the Bridger and Green river basin. This divide probably forms the junction of two great fresh-water lake basins, that may have existed contemporaneously. The two great basins may have been connected with each other at different points at some stages of their growth, but there is an abrupt, persistent, very marked difference in the character of the sediments of the two basins. While the Green River and Bridger Groups abound with fossils, the Wasatch Group, like all the rocks of the west that are characterized by brick-red coloring matter, is comparatively quite barren. At Bridger station, and from Bridger to Aspen, which is about 24 miles, the ochreous beds of the Wasatch Group are well exposed on both sides of the road, and the valley through which the road passes from Piedmont to Aspen is carved out of this Group

The tunnel at the head of Echo canon is cut through the reddish and purplish indurated sands and clays of the Wasatch Group. It is 770 feet in length. The valley of Echo canon is one of erosion, and on either side the rocks rise wall-like 500 to 1,000 feet, or have been weathered into curiously castellated forms, and bear such names as

Witches' Rock, Eagle Rock, Hanging Rock, Conglomerate Peak, Sentinel Rock, Monument Rock, etc. Monument Rock is a regular obelisk of conglomerate, standing at the junction of the Echo with the Weber valley, and being about 250 feet high. Descending the Echo canon, the more rugged picturesque scenery is exhibited on the right hand, and descending the Weber the same lofty perpendicular walls, weathered here and there into all sorts of fantastic forms, continue to the Narrows, where the Weber river makes a bend to the left, and the conglomerates disappear. The whole series of these beds is referred to the Wasatch Group, and the thickness estimated at from 3,000 to 5,000 feet, the conglomerate portion being from 1,500 to 2,000 feet.

He proposed the name of the "Sweetwater Group," for a lake deposit found in the Sweetwater valley. There is a high ridge or divide, between the drainage of Wind river, North Platte, and Sweetwater, 300 to 400 feet above the channels of these streams, which is composed of the Tertiary beds. The Sweetwater forms a distinct concavity, with this high divide on the north and east, and the valley has been scooped out so that until we reach the Sweetwater Canon, near the South Pass, only the massive granite ridges rise up among the modern Tertiary beds, which jut close up against their base. This is a valley of denudation, over a space of at least 30 to 50 miles in width. All the unchanged formations, from the lignite Tertiary down to the massive feldspathic granites, have been worn away, leaving the granites scattered over the valley in the isolated ridges. At that time there was a fresh-water lake which occupied the entire valley, much as Salt Lake once occupied the great basin, concealing most of the granite ridges, while others rose above the waters like islands. Then was deposited what he called the Sweetwater Group, or perhaps a series of beds identical with the upper portion of the Wind river deposits. These were scooped out again in time, and the Pliocene marls and sands were deposited; and then again there was another scooping out of the valley, and finally a covering of the hills with drift.

The mountainous portions of Northern Utah* are full of beautiful park-like areas, which contain the evidences of an ancient lake. At Copenhagen there is a considerable drift or bowlder deposit with fine white or yellow marly sands and clays, in regular layers, showing the deposit to be Post-pliocene, and that the waters of the lake were comparatively quiet. Near Box Elder Canon are two kinds of terraces,

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* U. S. Geo. Sur. of Montana, etc.

the usual lake terraces, of which there are two well-defined lines at least, and the river terraces, which are confined to the streams, and do not seem to have any direct connection with the former. The lowest plain valley opposite the canon, near the water's edge, is 4,344 feet above sea level; 1st terrace, 4,683 feet; 2d terrace, 4,776 feet; and 3d terrace, 4,858 feet. These terraces show the gradual decrease, step by step, of the waters of the ancient lake, and the operations of the little streams pouring into it from the mountains on either side. The amount of local drift that has been swept down through the gorges or canons and lodged at the opening is very great. At the immediate mouth of the canon, the bowlders are quite large, varying in diameter from a few inches to several feet. Westward toward the shore of the lake the bowlders diminish in size and quantity, and the finer sediments, as sands and marls, increase, showing a constant decrease in the power of the currents of the water after leaving the mouth of the canon.

The local drift is conspicuous in Logan Canon. It is composed of rounded bowlders, with clays and marls, reaching a thickness of 100 to 150 feet in regular and horizontal strata, attached to the sides of the gorge, and showing that, however turbulent the waters, the materials were deposited in a lake. At the entrance of the canon are some remarkable terraces, composed of sands, clays, marls and rounded bowlders.

A large portion of Utah is made up of nearly parallel ranges of mountains, trending nearly north and south, with intervening valleys of greater or less width, which, after their elevation, formed shore lines for detached lakes or bays. It would appear that the last lake-period of this portion of the west commenced in the Pliocene epoch, and continued on up to the present time; that the waters once filled all these valleys, so that they rested high upon the sides of the mountains, depositing what Prof. Hayden called the Salt Lake Group, gradually passing into the Post-pliocene deposits which verge upon our present period. It is quite possible that there have been oscillations of level in these modern lake-waters; but so far as the proofs go, this great inland lake may have continued quite uniform until the terrace epoch, and that then the waters gradually receded to their present position.

The immediate valley of Bear river, near the crossing, is interesting on account of the fine development of the lake-deposit, which is composed of clay, sand, and marl, yellow and rusty-drab color, and attains a thickness of 200 to 300 feet. The elevation of Bear river valley, at

the bridge, is 4,542 feet, and the highest terrace on the east side is 4,737 feet, and the highest on the west side is 4,779 feet. The immediate valley of Bear river may be said to have been worn out of the Pliocene or lake deposit.

Among the lower ranges of hills that border the east side of the Great Snake river basin, especially from Port Neuf Canon northward, the Pliocene deposits are well shown, and lie beneath the basaltic floor. In the Port Neuf Canon this fact is illustrated by the wearing away of the cap or floor of basalt, in a number of localities, but on the sides of the hills this is shown with equal clearness by the elevations of the basalt. The dip of the beds is not great, usually not more than 5° or 10,° and in all cases in the direction of the great basin. This would indicate that there had been a moderate elevation of the mountain ranges, or a depression of the basin at a very modern date, even approaching very close to our present period. The effusion of such a vast amount of igneous matter from the interior of the earth, might suggest the possibility, or even probability, that the cause of the subsequent changes in the hills around the borders, was either contemporaneous or subsequent to the effusion of the melted material. If the elevation began with the eruption, it certainly continued long after it ceased, inasmuch as the basalt is lifted up in thick beds, at the same angle with the underlying strata. Not only in the valley of the Port Neuf and Snake river is the basalt found in conjunction with lake deposits, but in numerous localities all over the northwest, it seems to rest upon these Pliocene beds, readily adapting itself by the form of the under surface to the irregularities of the surface of the lake deposits.

Prof. Eug. W. Hilgard* divided the Eocene of Alabama and Mississippi in descending order, into, 1st, Vicksburg Group, 120 feet; 2d, Red Bluff Group, 12 feet; 3d, Jackson Group, 80 feet; 4th, Claiborne Group, 60 feet; 5th, Buhrstone Group, 150 feet; 6th, Flatwoods and Lagrange Lignitic Group, 450 feet, making a total thickness of 872 feet. The Lagrange and Porter's Creek Group of Safford is the same as the Flatwoods and Lagrange Lignitic. The Buhrstone Group of Tuomey is the same as the Siliceous Claiborne Group of Hilgard.

The Eocence is followed by the Grand Gulf Group, probably a deposit in brackish water, almost non-fossiliferous, and having a thickness of 250 feet.

Prof. Leo Lesquereux† described, from the Green River Group of

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* Proc. Am. Ass., Ad. Sci.

† 1872, U. S. Geo. Sur. of Montana, etc.

Wyoming, high on hills from the river, *Ceanothus cinnamomoides*, now *Zizyphus cinnamomoides;* from the Bridger Group at Washakie station, near Bridger's Pass, *Rhamnus intermedius*, *Liquidambar gracile*, now *Aralia gracilis*, and *Quercus æmulans;* and from Barrell's Springs, *Equisetum haydeni.*

After reviewing the state of the knowledge of the Tertiary and Cretaceous flora of this country, he arrived at the following conclusions, to-wit:

1. The Tertiary flora of North America is, by its types, intimately related to the Cretaceous flora of the same country.

2. All the essential types of our present arborescent flora are already marked in the Cretaceous of our continent, and become more distinct and more numerous in the Tertiary; therefore the origin of our actual flora is, like its *facies*, truly North American.

3. Some types of the North American Tertiary and Cretaceous flora appear already in the same formations of Greenland, Spitzbergen, and Iceland; the derivation of these types is, therefore, apparently, from the arctic regions.

4. The relation of the North American Tertiary flora with that of the same formation of Europe, is marked only for North American types, but does not exist at all for those which are not represented in the living flora of this continent. Therefore, the European Tertiary flora partly originates from North American types, either directly from our continent, or derived from the arctic regions.

5. The relation of the Tertiary flora of Greenland and Spitzbergen with ours indicates, at the Tertiary and Cretaceous epochs, land connection of the northern islands with our continent.

6. The species of plants common to the Cretaceous and Tertiary formations of the arctic regions, and of our continent, indicate, in the mean temperature, influencing geographical distribution of vegetation, a difference, in +, equal to about 5° of latitude for the Tertiary and Cretaceous epochs.

7. The same kind of observation on the geographical distribution of vegetable species, shows at the Tertiary and Cretaceous times, differences of temperature according to latitude, analagous to what is remarked at our time, by the characters of the southern and northern vegetation.

Prof E. D. Cope* referred the Bridger Group to the Eocene, and described, from Cottonwood creek, Wyoming, *Mesonyx obtusidens*, *Triaco-*

* Pal. Bull., No. 1, and Proc. Am. Phil. Soc., vol. xii.

don aculeatus, *Lophiotherium pygmæum*, *Anostira œdemia*, now *Plastomenus œdemius*, *A. molopina*, now *P. molopinus*, *A. trionychoides*, now *P. trionychoides*, *Trionyx concentricus*, *T. thomasi*, now *Plastomenus thomasi*, *Axestus byssinus*, *Bæna hebraica*, *Testudo hadriana*, now *Hadrianus corsoni*, *Emys polycyphus*, *E. terrestris*, *Helotherium procyoninum*,* *Stypolophus pungens*, *Pantolestes longicaudus*, *Pseudotomus hians*, *Hadrianus octonarius*, *Hadrianus allabiatus*,† *Protagras lacustris;* from the Bad Lands of Black's Fork of Green river, Wyoming, *Stypolophus brevicalcaratus*, *S. insectivorus*, *Miacis parvivorus*, *Tomitherium rostratum*, and *Emys latilabiatus.*

He described,‡ from the Eocene of the upper waters of Bitter creek, Wyoming, *Synoplotherium lanius*, *Crocodilus clavis*, *Rhineastes peltatus*, *R. smithi*, *Loxolophodon cornutus*,§ *L. furcatus*, *L. pressicornis*, and *Palæosyops vallidens.* From the northern part of the Eocene basin of Green river, *Anaptomorphus æmulus*,‖ *Crocodilus sublatus*,¶ *C. sulciferus*, and *Anostira radulina.* From the lower beds of the Green River Group, near Black Buttes, *Alligator heterodon.* From the Wasatch Group, near Evanston, Utah, *Bathmodon radians*, *B. semicinctus*, *Notharctus* (now *Hyracotherium*) *vasacciensis*, *Notomorpha gravis*, *N. testudinea.* From the Eocene, at Osino, 25 miles northeast of Elko, Nevada, *Trichophanes hians* and *Amyzon mentale.* From the Green River Group of Wyoming,** *Erismatopterus rickseckeri*, and *Osteoglossum*, now *Dapedoglossus encaustum.*

He described, from the Eocene of New Jersey,†† *Lembonax propylæus*, *L. insularis*, and *Thecachampsa serrata.* And from the Miocene near San Diego, California, *Eschrichtius davidsoni.*

Prof. O. C. Marsh described,‡‡ from the Eocene near Fort Bridger, and near Henry's Fork, Wyoming, *Palæosyops laticeps*, *Telmatherium validus*, *Hyrachyus princeps*, *Homacodon vagans*, *Limnocyon verus*, *Viverravus gracilis*, *Nyctitherium velox*, *N. priscus*, *Talpavus nitidus*, *Limnofelis ferox*, *L. latidens*, *Limnocyon riparius*, *L. agilis*, *Thinocyon velox*, *Viverravus* (?) *nitidus*, *Thinolestes anceps*, *Telmalestes crassus*, *Limnotherium affine*, *Orohippus*

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* Pal. Bull. No. 2, and Proc. Am. Phil. Soc.
† Pal. Bull. No. 3, and Proc. Am. Phil. Soc.
‡ Pal. Bull. No. 6, and Proc. Am. Phil. Soc.
§ Pal. Bull. No. 7, and Proc. Am. Phil. Soc.
‖ Pal. Bull. No. 8, and Proc. Am. Phil. Soc.
¶ Pal. Bull. No. 9, and Proc. Am. Phil. Soc., vol. xii.
** U. S. Geo. Sur. of Wyoming.
†† Proc. Acad. Nat. Sci., Phil.
‡‡ Am. Jour. Sci. and Arts, 3d ser., vol. iv.

pumilus, *Helohyus plicodon*, *Thinotherium validum*, *Passalacodon litoralis*, *Anisacodon elegans*, *Centetodon pulcher*, *Stenacodon rarus*, *Antiacodon venustus*, *Bathrodon annectens*, *B. typus*, *Mesacodon speciosus*, *Hemiacodon gracilis*, *H. nanus*, *H. pucillus*, *Centetodon altidens*, *Entomodon comptus*, *Entomacodon minutus*, *Centracodon delicatus*, *Nyctilestes serotinus*, *Ziphacodon rugatus*, *Harpalodon sylvestris*, *H. vulpinus*, *Orotherium uintanum*, *Helaletes boops*, *Paramys robustus*, *Tillomys senex*, *T. parvus*, *T. lucaris*, *Sciuravus parvidens*, *Colonymys celer*, *Apatemys bellus*, *A. bellulus*, *Entomacodon angustidens*, *Triacodon grandis*, *T. nanus*, *Euryacodon lepidus*, *Palæacodon vagus*, *Aletornis nobilis*, *A. pernix*, *A. venustus*, *A. bellus*, *A. gracilis*, *Uintornis lucaris*, *Thinosaurus agilis*, *T. crassus*, *T. grandis*, *T. leptodus*, *T. paucidens*, *Glyptosaurus princeps*, *Oreosaurus vagans*, *Tinosaurus stenodon*, *Glyptosaurus brevidens*, *G. rugosus*, *G. sphenodon*, *Oreosaurus lentus*, *O. gracilis*, *O. microdus*, *O. minutus*, *Tinosaurus lepidus*, *Iguanavus exilis*, *Tinoceras grandis*, *Dinoceras lacustris*, and *Oreocyon latidens*. He described, from the Post-pliocene, near Bangor, Maine, *Catarractes affinis*, and from Monmouth county, New Jersey, *Meleagris celer*, and *Grus proavus*. Of the above list, it is stated by Cope that the new generic names are not generally defined.

Dr. Joseph Leidy* described, from the Bridger Group of Wyoming, *Uintacyon edax*, *U. vorax*, *Chameleo pristinus*, *Lepidosteus atrox*, *L. notabilis*, *L. simplex*, *Amia gracilis*, *A. media*, *A. uintensis*, *Hypamia elegans*, *Pimelodus antiquus*, *Phareodus acutus*, *Hyrachyus nanus*, *Microsyops gracilis*, *Palæacodon verus*, *Hipposyus formosus*, *Palæosyops junior*, *P. humilis*, and *Uintatherium robustum*. From the Niobrara Group, on the Niobrara river, in Nebraska, *Felis angustus;* from Green river, *Oligosomus grandævus;* from the Black Foot country at the head of the Missouri, *Tylosteus ornatus;* and from the Pliocene of Oregon, *Hadrohyus supremus*, *Rhinoceros pacificus*, and *Stylemys oregonensis*.

Prof. F. B. Meek † described, from the Green River Group at Washakie, Wyoming, *Unio washakiensis*, and from Pacific Springs, *Bythinella gregaria*.

T. A. Conrad‡ described, from the Eocene of North Carolina, *Ostrenomia carolinensis;* and from the Miocene of the same state, *Donax idoneus*.

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* Proc. Acad. Nat. Sci.
† Geo. Sur. of Wyoming.
‡ Proc. Acad. Nat. Sci.

In 1873, Prof. E. D. Cope* described, from the Bridger Group of Bitter creek, and Cottonwood creek, *Limnohyus lævidens;* from a bluff on Green river, near the mouth of the Big Sandy, Wyoming, *Palæosyops fontinalis;* from the summit of Church Butte, *Trionyx heteroglyptus;*† from the Bad Lands of Cottonwood creek, *T. scutumantiquum*, *Pappichthys plicatus*, *P. sclerops*, *P. lævis*, *P. symphysis*, *Rhineastes radulus ;* from Ham's Fork, *Bœna ponderosa*, *Clastes anax ;* from the Green River Group, near Evanston, Utah, *Bathmodon latipes ;* from near Black Buttes, *Emys euthnetus*, *E. megaulax*, *E. pachylomus;* from Upper Green river, *Pappichthys corsoni*, *Rhineastes calvus*, *R. arcuatus;* from Green river basin,‡ *Antiacodon furcatus*, now *Sarcolemur furcatus*, *Orotherium* (now *Hyracotherium*) *index;* from Cottonwood creek, *Microsyops vicarius*, *Oligotomus cinctus ;* from South Bitter creek, *Paramys leptodus*, *Eobasileus galeatus*, *Achænodon insolens*, from Henry's Fork, *Palæosyops diaconus*, *Hyrachyus implicatus;* from near Evanston, *Phenacodus primævus*.

He described, from the Miocene of Colorado,§ *Hyopsodus minimus*, *Hypertragulus calcaratus*, *H. tricostatus*, and *Menotherium lemurinum;* from the Miocene of the Western plains,‖ *Aelurodon mustelimus*, now *Mustela parviloba*, *Aphelops megalodus*, *Palæolagus agapetillus*,¶ *Colotaxis cristatus*, *Hyracodon quadriplicatus*, now *Anchisodon quadriplicatus*, *H. arcidens*, *Symborodon torvus*, *Miobasileus ophryas*, *Megaceratops acer*, *M. helocerus*, *Peltosaurus granulosus*, *Testudo amphithorax*, *T. cultratus*, *T. laticuneus*, *T. ligonius*, *Domnina gradata*,** *Herpetotherium fugax*, *Daptophilus squalidens*, *Tomarctus brevirostris*, *Stibaru obtusilobus*, *Canis gregarius*, *Isacis* (now *Miodectes*) *caniculus*, *Palæolagus triplex*, *P. turgidus*, *Tricium avunculus*, *T. leporinum*, *T. paniense*, *Gymnoptychus minutus*, *G. nasutus*, *G. trilophus*, *Anchitherium cuneatum*, and *Trimerodus cedrensis*.

Prof. O. C. Marsh†† described, from the Eocene deposits of Wyoming and Oregon, *Dinoceras mirabilis*, *Orohippus agilis*, *Colonoceras agrestis*, *Dinoceras lucaris*, *Oreodon occidentalis*, *Rhinoceras annectens* *R. oregonensis*, *Tillotherium hyracoides ;* from the Miocene of Colora-

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* Proc. Am. Phil. Soc., vol. xiii.
† U. S. Geo. Sur., Wyoming, etc.
‡ Pal. Bull. vol. xii.
§ Proc. Acad. Nat. Sci.
‖ Pal. Bull. vol. xiv.
¶ Pal. Bull. No. xv.
** Pal. Bull. No. xvi.
†† Am. Jour. Sci. and Arts, 3d ser., vol. v.

do, *Brontotherium gigas*, and *Elotherium crassum;* and from the Upper Eocene of Wyoming,* *Dinoceras laticeps.*

Dr. Joseph Leidy† described, from the Bridger Group in the Buttes of Dry creek, *Hyopsodus minusculus*, *Mysops fraternus*, *Washakius insignis*, *Saniva major ;* from the Grizzly Buttes, *Sinopa eximia ;* from the Buttes, ten miles from Dry Creek Canon, *Amia uintaensis;* from the junction of Sand and Green rivers, *A. media ;* from Henry's Fork, *A. gracilis ;* from Dry creek, *Hypamia elegans ;* from the junction of Big Sandy and Green rivers, *Lepidosteus atrox*, now *Clastes atrox ;* from Washakie station, *L. simplex*, *L. notabilis*, now *Clastes notabilis ;* from Big Sandy and Green rivers, *Pimelodus antiquus*, *Phareodus acutus*, *Clupea alta*, now *Diplomystus altus ;* from the Miocene of Bridger creek, a tributary of John Day's river, one of the branches of the Columbia, in Oregon, *Dicotyles pristinus*, *Elotherium imperator ;* from Washington county, Texas, *Anchitherium australe ;* from Red Rock creek, a tributary of Jefferson Fork of the Missouri, *Anchitherium agreste ;* from Richmond, Virginia, *Procamelus virginiensis*, *Tautoga conidens*,‡ *Acipenser ornatus ;* from the Post-pliocene of California, *Felis imperialis*, and *Auchenia hesterna.*

Prof. F. B. Meek§ described, from Church Buttes, *Physa bridgerensis;* from twelve miles south of Fort Bridger, *Pupa leidyi;* and from the upper beds exposed at Separation, on the U. P. R. R., *Limnæa compactilis.*

Prof. Lesquereux described, from South Park, near Castello's Ranch, *Ophioglossum alleni*, and *Planera longifolia;* from Elko station, *Sequoia angustifolia*, *Thuya garmani*, and *Abies nevadensis.*

In 1874, Prof. E. D. Cope‖ described, from the Bridger Group of South Bitter creek, *Eobasileus galeatus*, and *Achænodon insolens ;* from the Miocene of Colorado, *Symborodon hypoceras*, *Anchitherium exoletum*, and *Hippotherium paniense.* He described from the Eocene of the Middle and South Parks, Colorado,¶ *Amyzon commune*, and *Clupea theta*, now *Diplomystus thetus ;* from the White River Group, *Hypertragulus tricostatus*, *Elotherium ramosum*, now *Pelonax ramosus*, and *Menotherium lemurinum ;* from the Loup Fork Group,

* Am. Jour. Sci. and Arts, 3d ser., vol. vi.
† Cont. to Ext. Vert. Fauna, W. Terr.
‡ Proc. Acad. Nat. Sci.
§ 6th Ann. Rep. U. S. Geo. Sur. Terr.
‖ 7th Ann. Rep. U. S. Geo. Sur. Terr.
¶ Bull. U. S. Geo. Sur. Terr.

Protohippus sejunctus, *Procamelus angustidens*, *P. heterodontus*, and *Merycodus gemmifer*, now *Blastomeryx gemmifer*.

He determined that the lacustrine deposit in the valley of the Rio Grande, called the Santa Fe marls, is of Pliocene age, and described* *Martes nambianus*, now *Putorius nambianus*, *Cosoryx ramosus*, now *Dicrocerus ramosus*, *C. teres*, now *D. teres*, *Hesperomys loxodon*, now *Eumys loxodon*, *Panolax sanctæfidei*, *Cathartes umbrosus*, now *Vultur umbrosus*, *Mastodon productus*, and *Steneofiber pansus*.

Prof. O. C. Marsh† described, from the Eocene of Wyoming, *Orohippus major*, *Stylinodon mirus*, and *Tillotherium latidens;* from the Miocene of Colorado, *Brontotherium ingens;* from Nebraska, Dakota and Oregon, *Miohippus annectens*, *Anchitherium anceps*, *A. celer*, *Anchippus brevidens*, and *Elotherium bathrodon;* and from Pliocene strata of the west, *Pliohippus pernix*, *P. robustus*, *Protohippus avus*, *Morotherium gigas*, and *M. leptonyx*.

Prof. Leo Lesquereux described,‡ from Elko, Nevada, *Lycopodium prominens*, *Myrica partita*, *Quercus elkoana*, *Diospyros copeana*, *Sapindus coriaceus;* from Middle Park, *Salvinia cyclophylla*, *Ulmus tenuinervis*, *Sapindus angustifolius*, *Staphylea acuminata*, *Rhus drymeja*, *R. haydeni*, *Pterocarya americana;* from Green river, *Equisetum wyomingense;* from Florissant, South Park, *Acorus affinis*, *Myrica copiana*, *Weinmannia rosæfolia*, *Ilex subdenticulata*, *I. undulata*, *Paliurus florissanti*, *Cæsalpinia linearis*, *Acacia septentrionalis*.

The Eocene§ is found in North Carolina, between the Neuse and the Cape Fear, and in limited outcrops throughout the triangular region between Newbern, Goldsboro and Wilmington. It consists of a light colored, consolidated marlite, as in the steep bluffs on the Neuse, 10 miles below Goldsboro, or of a shell conglomerate as seen about Newbern, and 8 or 10 miles up Trent river, or of a white calcareous sandstone, more or less compacted, as on the Neuse near Goldsboro; or of a gray and hard limestone, as about Richlands in Onslow; or of a coarse conglomerate of worn shells, sharks' teeth, and fragments of bones and stony pebbles, as in the upper part of Wilmington and at Rocky Point; or of a fine shaly infusorial clay, light gray to ash colored, as in Sampson county near Faison's depot. The outliers show that the formation, though limited in thickness, had a great horizontal extent, and once extended quite into the hill country of the State, and

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* Proc. Acad. Nat. Sci. Phil.
† Am. Jour. Sci. and Arts, 3d ser., vol. vii.
‡ 7th Ann. Rep. U. S. Geo. Sur. Terr.
§ Geo. of N. Carolina, 1875.

nearly 150 miles from the present coast line, and to an elevation of nearly 400 feet.

The Miocene occurs in disconnected patches, in river bluffs and in ravines over the seaboard region, and extending from the shore and the western margins of the sounds 50 to 75 miles inland. It consists of beds of clay, sand and marl, which are locally filled with shells from 2 to 8 feet, and occasionally 10 to 20 feet.

Prof. Theo. B. Comstock* said the Green River Group is used to designate that portion of the fresh-water Tertiary strata which lies directly above the coal group, and which is the present surface formation over a large portion of the Green river basin, north of Fort Bridger. The upper limit is not readily definable at present, the transition between the beds of this and the overlying group being rather gradual, but the general character of the two formations, both lithologically and palæontologically, differs greatly. The Green river beds are mainly composed of a series of shales, marls, and harder calcareous strata, the latter especially containing quantities of the remains of fresh-water forms of life, with laminated layers, literally filled with the remains of land plants of the Phænogamous series. The outline of the ancient lake-basin, in which these strata were deposited, is not fully determined, but there are indications that its eastern boundary was outside of the present limits of the Green river basin, and there is no room for doubt that the Uinta mountains, and the Wahsatch chain, then, as now, towered above its surface. Northward it is equally clear that the Wind River Range formed the shore of the great lake, with probably more or less of gently sloping border during a portion of the era of Lower Eocene deposition. The excessive erosion has exposed the beds over the route from Fort Bridger to near South Pass, and generally speaking, the rock contains a considerable portion of calcic carbonate, with an abundance of ferric oxide produced by decomposition and oxidation. Gypsum and calcite of different varieties are abundant, frequently occurring as thin, papery seams between the rock-layers, at other times forming masses of considerable extent. Some of the layers are little more than a pure clay shale, while there are a few quite arenaceous beds and some compact limestones. The texture of the different beds is quite variable, but, in general, the streams which have cut their channels through them are walled by nearly vertical cliffs, and the buttes and benches for the most part have

* Rep. of Reconnaissance of Yellowstone river and N. W. Wyoming.

quite precipitous sides. Numerous joints occur in many of the strata, particularly in the more compact kinds, and fine examples of concretionary structure or weathering are not rare. The tendency of the thick beds of marly sandstone on the banks of Green river, at the crossing, to weather spheroidally, is very noticeable, and this is repeated in various degrees in the argillaceous and calcareous rocks as well.

The Bridger Group, though succeeding the Green River Group, is closely related to it, for the transition from one to the other is not abrupt, either in the structure of the beds or their contents. The Group is exposed at the surface over a considerable extent of country, northward and eastward from Fort Bridger as far as Little Sandy river and beyond, forming the top layers of numerous isolated buttes, During this epoch it is probable that the land was covered with fresh water in a lake as large as in the previous era, if not more extensive. The beds are mainly composed of dull-colored, indurated clays, and arenaceous layers of considerable thickness, the latter usually brownish, or dull yellow or gray, often with more or less of a concretionary structure. The clays are generally compacted, but they become disintegrated upon exposure to the atmosphere, and readily yield to the eroding forces. Some thinner layers of more calcareous material, with silicious seams, often affording interesting concretions, are interspersed, but they are rather exceptional than otherwise. The Green river and Bridger Groups are readily distinguished by the effects produced by erosion. The former presenting nearly vertical cliffs, so that the impression in crossing the country where it forms the surface rocks is that of traveling over an ordinary plain with occasional descents, by a succession of terraces, to the narrow valleys of the streams. On the contrary, where it is concealed, or only occasionally capped by the Bridger Group, the country is very irregular, often simulating the "Bad Lands;" the beds of the latter being eroded without complete denudation, so that they stand out in buttes, or rude architectural forms.

The deposits in the Yellowstone Lake basin, and in the valley of the main river and its tributaries, which may be regarded as Pliocene, are mainly the sediments of an ancient lake, of which the present body of water is the representative on a much reduced scale. Beautiful and highly instructive sections of the old beach formations are exposed in the valleys of the streams, particularly in the lower valley of Pelican creek, and far down the Yellowstone river, where they become more complicated and more interesting. An examination of these shows that the lake formerly extended over a much larger area, and that it

has held its place amid changes of great importance. It was during the latter portion of the Tertiary age that much of the volcanic activity took place which was so general over this portion of the country, though probably only the closing stages of the lava flows are represented by the eruptive deposits of the Pliocene epoch. A section on the present lake shore, between Bluff Point and Steam Point, in descending order, is as follows:

1. Grass-covered soil passing gradually to loose sand, 2 feet.

2. Various sand, gravel, and spring deposits with scattered irony concretions, 6 feet.

3. White and dark lake sand, very thinly laminated with beach structure, and occasional irony layers, 5 feet.

4. About 15 feet of thinly laminated, blue-black clay, locally contorted and beautifully cut by a small rill, emanating as a spring from one of the irony layers in No. 3. The water is slightly chalybeate.

Other sections show the same general features with more or less variation. They represent the upper portion of the Pliocene series, deposited toward the close of volcanic activity, hence the occasional beds of volcanic ejectamenta which were poured out into the lake, are mainly composed of volcanic sand and the finer textured conglomerates, as may well be seen near Steamboat springs. As we descend the valley of the Yellowstone river, we find the lower members of the group well exposed, and the beds of unmodified non-molten material becoming more common, with increasing proportions of the molten or lava series, until the latter are almost universal, and doubtless represent an earlier period, though frequently largely concealed by the subsequent spring deposits. Near the close of the Pliocene epoch, the internal fires had so far died out that the igneous ejections were of fitful occurrence, and geysers, solfataras, fumaroles, etc., abounded to an almost incredible extent, giving rise to enormous deposits of siliceous and calcareous material, which has continued to be deposited with decreasing vigor until the present day.

Prof. G. K. Gilbert* found a section of Tertiary on the east face of Sam Pitch Plateau, at Wales, Utah, 1,292 feet in thickness, another near the head of the main Sevier river, in Utah, 560 feet, and another on the north fork of Virgin river, between Mountain Lakelet and Rockville, in Southern Utah, estimated at 3,000 feet.

Prof. E. D. Cope† described the Puerco marls as in all probability

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* Geo. Sur. W. 100th Meridian, vol. iii.

† Ann. Rep. Explr. and Sur., W. 100th Meridian App. L. L.

a lacustrine formation of Eocene age, though having examined an outcrop for forty miles, he discovered no fossil remains except fossil wood. He said the material is so easily transported that the drainage channels are cut to a great depth, and the Puerco river becomes the receptacle of great quantities of slimy-looking mud. Its unctious appearance resembles, strongly, soft soap, hence the name *Puerco*, greasy. These soft marls cover a belt some miles in width, and continue at the foot of another line of sandstone bluffs, which bound the immediate valley of the Puerco to a point eighteen miles below Nacimiento.

This section of the Eocene strata in the region west of the Sierra Madre Range in New Mexico consists of green and black marls, which he named the Puerco Group, 500 feet; sandstone of the Wasatch Group 1,000 feet, and red and gray marls of the same group, 1,500 feet; making a total thickness of 3,000 feet.

He described,* from the Eocene of New Mexico, *Ambloctonus sinosus*, *Prototomus secundarius*, *P. multicuspis*, *P. strenuus*, *Diacodon alticuspis*, *D. cœlatus*, *Pelycodus frugivorus*, *Pantolestes chacensis*, *Opisthotomus astutus*, *O. flagrans*, *Antiacodon mentalis*, *A. crassus*, *Hyrachyus singularis*, *Hyracotherium tapirinum*, *H. angustidens*, *H. cuspidatum*, *Bathmodon latidens*, *B. cuspidatus*, *Diplocynodus sphenops*, *Crocodilus grypus*, *C. wheeleri*, and *Dermatemys* (?) *costilatus*.

He described,† from the Miocene of Cumberland county, New Jersey, *Phasganodus gentryi*, *Sphyrænodus silovianus*, and *Agabelus porcatus*; from Flower's marl pit, Duplin county, North Carolina,‡ *Pristis attenuatus*; from Edgerton's plantation, in Wayne county, *Pneumatosteus nahunticus*; from Halifax county, *Mesoteras kerrianus*, and *Delphinapterus orcinus*. From the Loup Fork Group of New Mexico,§ *Pliauchenia humphreysana*, *P. vulcanorum*, *Hippotherium calamarium*, and *Aphelops jenezanus*; and from the Pliocene of the West, *Canis ursinus*.

Prof O. C. Marsh‖ described, from the Eocene of Wyoming, *Lemuravus distans*, *Tillotherium fodiens*; from Utah, *Diceratherium advenum*, *Diplacodon elatus*, *Orohippus uintensis*, and *Agriochœrus pumilus*. From the Miocene bad lands of Nebraska, *Laopithecus robustus*, *Anisacodon montanus*; from the John Day river in Oregon,

* Geo. Sur. W. 100th Meridian, Syst. Catal. of Vertebrata.
† Proc. Am. Phil. Sci., vol. xiv.
‡ Geo. of N. Carolina.
§ Proc. Acad. Nat. Sci.
‖ Am. Jour. Sci. and Arts, 3d ser., vol. ix.

where the beds have an estimated thickness of 5,000 feet, *Diceratherium armatum*, *D. nanum*, *Thinohyus lentus*, and *T. socialis*.

T. A. Conrad* described, from the Eocene at Wilmington, North Carolina, *Terebratula demissirostra;* and from Beaufort, *Pecten anisopleura* and *P. carolinensis*.

From the Miocene near Wilmington, and other places in North Carolina, *Liropecten carolinensis*, *Ostrea perlirata*, *Placunomia fragosa*, *Raeta alta*, *R. erecta*, *Abra bella*, *A. holmesi*, *Noetia protexta*, *N. filosa*, *Mercenaria carolinensis*, *Leptothyris parilis*, *Trachycardium bellum*, *Mysia carolinensis*, *Saxicava protecta*, *Turritella perexilis*, *T. carolinensis*, *Fissurella carolinensis*, *Littorina carolinensis*, *Busycon kerri*, *B. amoenum*, and *B. concinnum;* from Suffolk, Va., *Zizyphus virginicus*.

W. H. Dall† described, from the Miocene at Cerros Island, California, *Waldheimia kennedyi;* from the Pliocene at San Diego, *Chrysodomus diegoensis*. And R. C. Stearns‡ described, from the same strata, *Opalia anomala*, and *O. varicostata*.

In 1876, Prof. J. W. Powell§ subdivided the Tertiary rocks of the plateau province of the west in ascending order, into the "Bitter Creek Group," which is synonymous with the Wasatch Group, and has a thickness of 5,000 feet. It is succeeded by the Lower Green River Group, consisting of shales, often bituminous; sandstones; carbonaceous shales and lignitic coal near the base. Thickness, 800 feet.

This group is well exposed along Green river, from Green River station southward for 10 miles; in many of the escarpments of the Quien Hornet mountain, and a few miles northeast from the head of Vermilion canon; on Snake river, six miles above the northern foot of Junction mountain; and on the elevated ledges known as Pine Bluffs, near the sources of the eastern tributaries of Vermilion creek. The beds are all fresh water.

The Upper Green River Group consists of sandstones, sometimes argillaceous limestones, carbonaceous shales and lignitic coal, near the middle and in the lower part massive or irregularly bedded sandstone, ferruginous. Unconformable by erosion with lower Group. Thickness, 500 feet.

The plant beds of this group are well exposed to the north of Green River station, and between that point and Alkali stage station, in many gulches and canons; in the cuts of the Union Pacific Railroad

* Geo. of N. Carolina.
† Proc. Cal. Acad. Sci., vol. v.
‡ Proc. Acad. Nat. Sci. Phil.
§ Geo. of Uinta Mountains.

between Green River station and Bryan and in the escarpments on either side of Henry's Fork at many places. The Tower sandstone is well shown in the cliffs at Green River station, and in that vicinity and below the mouth of Currant creek. The Tower sandstone is laid down unconformably on the Lower Green River Group, the unconformity being represented by gentle valleys of erosion.

The Bridger Group consists of Bad Land sandstones (chiefly green sands) limestones, shells, marls, and concretionary and stratified flints. Thickness, 2,000 feet.

It is well exposed in the vicinity of Fort Bridger, at Church Buttes, at Haystack mountain and in the Cameo mountains. An outlying patch is found north of the Dry mountains between Vermilion creek and Snake river. Unconformity with the beds of the Lower Green River Group may be seen in the vicinity of Carter station, but unconformity with the Upper Green River Group has not been observed. The two are separated, however, upon lithological grounds, though the plane of demarkation is obscure. The moss agates for which the region about Fort Bridger has been noted are from irregular beds and aggregations of chalcedony in this Group.

The Brown's Park Group consists of sandstones, gravels, limestones, concretionary and stratified flints. Unconformable with all underlying rocks. Thickness, 1,800 feet.

It is well represented at Brown's Park, in northeastern Utah, and in northwestern Colorado. About five miles above the confluence of Snake river with the Yampa, the beds may be seen resting unconformably against Carboniferous strata, and on going north they may be observed to rest unconformably with the Bridger Group.

In Brown's Park, it lies in a deep basin of erosion, the bottom and sides of which are composed of Uinta sandstone. This basin is in the very axis of the Uinta uplift. Its sandstones are Bad Land rocks of exceedingly fine texture. In some places there are extensive and irregular aggregations of chalcedony.

The Bishop's Mt. Conglomerate, which is unconformable by plication and erosion with underlying rocks. Thickness, 300 feet. It is found on the summits of Bishop and Quien Hornet mountains, and upon various tables in the Uinta mountains. On the north side of Connor basin, at the head of Sheep creek, this conglomerate has a thickness of more than 1,000 feet. It is neither a marine nor lacustrine deposit. but a subærial one.

Prof. Powell says, witnessing on every hand the accumulation of such

gravels in valleys and over plains where mountains rise to higher altitudes on either side, and having in many cases actually seen the cliffs breaking down, and the gravels rolling out on the floods of a storm, I am not willing to disregard explanations so obvious, and so certain, for an extraordinary and more violent hypothesis. Irregular accumulations of clay, accumulations of sand, of gravels, and bowlders, having, in a general way, all the lithologic characteristics of "drift," are very common in the Rocky mountain region, and in many cases their origin can be traced to ordinary atmospheric agencies acting on the adjacent hills and mountains; and no glaciers or icebergs are needed for their explanation.

We learn from Dr. Hayden,* that on the high divide between the drainage of the Arkansas and South Platte rivers, there occur fresh-water lake deposits, having a thickness of 1,000 or 1,500 feet, and covering an area of about 40 miles from north to south, and 50 miles from east to west, or about 2,000 square miles, called by Dr. Hayden, in 1869, the "Monument Creek Group," from the fact that the atmospheric agents have carved out of the beds peculiar monuments or columns. He referred the deposits to Miocene or Pliocene age ; later, in 1873, Prof. Cope, from the evidence of the hind leg and foot of an *Artiodactyle*, and a fragment of *Megaceratops coloradoensis*, referred the deposits on the Colorado divide, perhaps the same, to the age of the Miocene. The texture of the rocks is quite varied.

The lower portion is composed of rather massive beds of sandstone, varying from a pudding-stone to a fine-grained sandstone, usually of a light color, sometimes of a yellow or iron-rust, with their intercalations of arenaceous clay. In the distance, the whole group, in many localities, presents a chalky-white appearance. At the immediate base of the mountains, just south of the small lake on the divide, the rocks are variegated sandstones, brick-red, white and yellow, varying in texture from a fine sandstone to a pudding-stone, with all the signs of deposition in moving waters. Still farther north, on the divide proper, the beds jut against the granites, inclining not more than 3°, and are made up of a coarse aggregate of feldspar and quartz crystals, so that it resembles a very coarse granite. It is plain that the sediments of this group were derived very largely from the granitoid rocks. The sediments become finer and finer as they recede eastward from the foot of the mountains into the plains.

* U. S. Geo. and Geogr. Sur. of Colorado and Adjacent Territory.

To the eastward of the line of the Denver and Rio Grande Railroad, the surface is cut up into more or less rectangular masses, with rather broad table-shaped summits, varying from 400 to 800 feet in height. The sides are often very steep, almost inaccessible. At a remote period in the past, the erosion has been very great, carving out by an almost inappreciably slow process, these broad valleys, leaving these buttes here and there, composed of horizontal beds, to aid in forming some conception of the amount of denudation which has taken place. It is not possible at the present time to estimate the original thickness of this group, but believe it to have been very much greater than the highest beds now existing would indicate. The summits of many of the buttes are capped with a greater or less thickness of a beautiful purplish trachyte, which must have ascended in the form of dikes from beneath, and flowed over the surface. Much of the trachyte is a sort of breccia, composed of rather coarse sandstones, which must have been caught in the melted material. It is quite evident that these outflows occurred during the existence of the lake, though at a late period. Dr. Hayden synchronized the age of this group with the upper portion of the White River Group far to the northward, and probably with the fresh-water deposits in the South Park.

Lake basins have occupied a large part of the country from the Isthmus of Darien to the Arctic Circle. In many instances they were merely expansions of river valleys, like the greater number of the lake basins of the present time. During the later Cretaceous and early Tertiary periods, the western portion of the continent was covered with immense lakes, but during the Pliocene and the interval to modern time, thousands of small lakes, with a few of large size, were distributed over the great area west of the Mississippi, and the basins with their peculiar deposits are found in the parks, among the mountains, and along every important valley.

Dr. Hayden believed there are evidences of glacial action and morainal deposits in the valley of the Upper Arkansas river, at elevations of 9,000 feet and upward, and along both flanks of the Sawatch mountains; but, he said that he observed no proof of any wide extended drift-action, like that of the New England States, in the Rocky mountains, as the superficial deposits are all of local origin, and the source is limited to the drainage of the streams in which the deposits are found. For example, all the marls and coarser deposits in the valley of the Upper Arkansas, have the same origin, and the forces that produced them were limited geographically to the drainage

of that stream. That not a fragment of rock had been transported even from so short a distance as beyond the drainage west of the Sawatch, or east of the Park ranges. He placed the superficial deposits in one great period, extending from the Pliocene up to the present time, because in the aggregate they afford no proof of any break in the order of time. In the valley of Roaring Fork in the Elk mountains, the morainal deposits are remarkable for their thickness. The surface is covered with huge bowlders, some angular, and others partially rounded. The terraces are very conspicuous, rising, in some instances, to 1,000 feet or more above the bed of the stream, and strewed over with huge bowlders. None of the stray materials in any of the valleys or gorges seem to have been transported a very great distance, and never, under any circumstances, is there any drift or glacial deposits from a neighboring drainage ; in other words, the loose material does not pass from one independent valley to another. So it is all over the Rocky mountain region. All the drift or Post-pliocene deposits are local.

Prof. E. D. Cope* described, from the Eocene of New Mexico, the giant bird *Diatryma gigantea;* and from the Pliocene, phosphate beds of South Carolina, *Cyclotomodon vagrans.*

Prof. O. C. Marsh† described, from the Eocene of the Rocky mountain region, *Eohippus validus*, *E. pernix*, *Parahyus vagus*, *Dromocyon vorax*, *Dryptodon crassus*, and *Coryphodon hamatus.*

Dr. Joseph Leidy‡ described, from the Eocene of New Jersey, *Myliobates fastigiatus*, and *M. jugosus;* from the Pliocene beds of Ashley river, South Carolina, *Belemnoziphius prorops*, *Choneziphius liops*, *C. trachops*, *Eboroziphius coelops*, *Proroziphius macrops*, *Myliobates magister*, *M. mordax*, and *Proroziphius chonops.*

Prof. C. A. White§ described, from the Eocene at Bijou basin, 40 miles east of Denver, Colorada, *Corbicula powelli*, *Mesodesma*, *bishopi*, *Phorus exoneratus ;* from Crow creek, *Melania larunda;* from the West, *Tulotoma thompsoni ;* from the Lower Green River Group, 8 miles below Green River station, Wyoming, *Helix riparia ;* from the Upper Green River Group, at Henry's Fork and Alkali station, *Unio shoshonensis*, *Succinea papillispira*, *Pupa incolata*, and *P. arenula.*

Prof. F. B. Meek‖ described, from the White River Group, on Pinot's creek, *Limnæa shumardi.*

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* Proc. Acad. Nat. Sci.

† Am. Jour. Sci. and Arts, 3d ser., vols. xi and xii.

‡ Proc. Acad. Nat. Sci.

§ Geo. of Uinta Mountains.

‖ Hayden's U. S. Geo. Sur. Terr.

G. T. Bettany* described, from the Miocene of John Day's river, Oregon, *Merycochœrus leidyi*, and *M. temporalis*.

J. A. Allen† described, from the lead crevices and superficial strata of the lead region of Wisconsin, Iowa, and Illinois, of supposed Pliocene age, *Canis mississippiensis*, and *Cervus whitneyi*. Charles M. Wallace found flint implements in the stratified drift, near Richmond, Virginia, which he referred to Post-pliocene age.

In 1877, Dr. F. M. Endlich‡ found the Puerco Group forming the lowest member of the Wasatch, and well developed in southern Colorado. It was best observed on the Lower Animas, where it consists of 1,000 to 1,200 feet of variegated shales and marls. At the base, they are a muddy green, changing into yellow or almost blue. Farther up, pink, pale orange, lilac, and reddish colors predominate, varied by interstrata of white or light yellow. Thin beds of sandstone merely of local occurrence, however, separate these beds; not forming definite recognizable horizons. Farther east, these variegated marls gradually change into shales and sandstones, so that they are no longer characteristic. Above them there occur 1,000 feet of yellow to brown sandstones and shales. As a rule the beds of sandstone are heavy, weathering massively, but they frequently show but small thickness, and are interstratified with yellow and grayish shales. In some of the shales, indications of coal may be observed, but nowhere throughout the San Juan region was any vein found that would have been sufficiently large, or of good quality to be worked.

All the lower canons of the San Juan drainage, and that of the river itself, are formed by this series of sandstones, and others superincumbent. Over the entire region which they cover, they are uniform, both in occurrence and in lithological character. Their very small dip to the south, 2° to 4°, and their total thickness of 3,000 feet, enables them to extend over a large area of country.

Dr. B. F. Mudge found the Pliocene strata of Kansas resting directly upon the Cretaceous. The material of the Pliocene deposits consists of sandstone of various shades of gray and brown, occasionally whitened by a small admixture of lime. The lower strata are usually composed of finer sand than the upper, and much more loose and friable in their texture. The overlying beds are of coarser ingredients, consisting of water-worn pebbles of metamorphic rocks, quartz, green-

* Quar. Jour. Geo. Soc. Lond., vol. xxxii.
† Am. Jour. Sci. and Arts, 3d ser., vol. xi.
‡ 9th Ann. Rep. U. S. Geo. Sur. Terr.

stone, granite, syenite, and sometimes fragments of fossil wood from an older formation. These portions of the deposit, when crumbled, and the finer parts washed away, have much the appearance of drift, and have been mistaken for it.

At Breadbowl Mound, Phillips county, it is about 200 feet above Deer creek, and at Sugarloaf Mound, in the western part of Rooks county, it is about 300 feet above the Solomon river. On Prairie Dog creek, in Norton county, it is 400 feet in thickness, and in the extreme northwestern part of the State it is still thicker. The formation like all the rest in the State, appears to dip slightly to the northwest.

In the southern portion of the Pliocene, in the vicinity of Fort Wallace and Sheridan, the hill-tops are covered with a stratum about eight feet in thickness, very hard and siliceous. The material varies from coarse flint-quartz to chalcedony. The latter mineral shades from milk white to transparent, sometimes presenting a semiopal appearance. The so-called moss agate is found in the upper few inches of the stratum. This cap rock is interesting to the mineralogist by showing the moss agate in its various stages of formation. The lower portion of the eight feet indicates an imperfect chemical solution of the silica and black oxide of manganese, therefore the crystalization of the latter is imperfect. As we examine the strata from the bottom to the top, we find the chemical conditions more favorable and complete, so that the distinct quartz, chalcedony, and manganese of the bottom become more commingled toward the upper inch or half inch, where the silica must have been sufficiently fluid to allow the manganese to assume the form of sprig crystals. This peculiar deposit is common on all the high hill-tops of Wallace county.

In King's Geo. Sur.,* the Tertiary is divided into Eocene, Miocene, and Pliocene, each of which is again sub-divided in ascending order as follows. Eocene—1. Vermillion Creek Group ; 2. Green River Group; 3. Bridger Group ; 4. Uinta Group. Miocene—1. White River Group; 2. Truckee Group. Pliocene—1. North Park Group ; 2. Humboldt Group ; 3. Niobrara Group ; 4. Wyoming Conglomerate. The "Vermillion Creek Group," is a synonym of the Wasatch, and the "Uinta Group," of the Brown's Park Group, and worse than all, the "Niobrara Group" was a pre-occupied name for a Cretaceous Group.

S. F. Emmons estimated the Eocene of the Green river basin at 7,500 feet in thickness. The beds of the Wasatch series, which are

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* Geo. Sur., 40th Parallel.

chiefly arenaceous, were deposited in greater thickness than either of the other groups, and extended from the base of the Park range to the flanks of the Wasatch mountains. The beds of the Green river series contrast with those of the other two groups by the relative prevalence of calcareous material, and the fineness of their sediments. They consist of a lower series of calcareous sandstones and impure limestones, containing some lignite seams, overlaid by a great thickness of remarkably fissile calcareous shales, abounding in remains of fish and insects, which reach an aggregate thickness of about 2,000 feet, and are characterized throughout by their prevailing white color. The Bridger Group consists of a thickness of about 2,500 feet of arenaceous beds, with a small development of calcareous material, of a prevailing dull, greenish-gray color, characterized by the great quantity of vertebrate remains which have been buried in them. Its greatest development is in the southern portion of the Bridger basin. In the Washakie basin, on the western borders of the Little Muddy creek, and at Washakie mountain and Cathedral bluffs, the Wasatch series are exposed, weathering in castellated forms, and recognizable from great distances by their bright pinkish and reddish coloring. Washakie mountain and the line of bluffs which extend to Cathedral bluffs, are formed of beds of the Green river series in the upper portion, and with the red Wasatch beds at the base, the line of division can be distinctly traced, descending somewhat in horizon toward Barrel springs, and ascending again beyond toward Cathedral bluffs. A section taken at Sunny Point, near Little Snake river, gave a thickness from the river to the summit of the cliff of about 2,000 feet. The upper 950 feet belonging to the Green river series, and the remaining 1,050 feet to the Wasatch Group. The Green River Group is exposed in the valley of Brown's Park, which is a bay-like depression, from 6 to 8 miles in width, occupying the geological axis of the eastern end of the Uinta mountains, from 1,000 to 1,200 feet in thickness. Throughout the valleys of the Little Snake and Yampa rivers, these groups have been worn into rounded ridges, where, generally, only disintegrated material is found.

In the basin of Vermillion creek, the beds of the Wasatch Group have their greatest development. It was on one of the broad benches, between the branches of this creek, to the east of Ruby Gulch, that the originators of the famous diamond fraud, of the summer of 1872, located their pretended discovery. An exposure of coarse, iron-stained sandstone, on the surface of the mesa, at the foot of Diamond Peak, was strewn by them with rough diamonds and rubies, which were in-

geniously mixed with the soil around, so as to make it appear that they came from the decomposition of the sandstone.

Along Bear river, in Utah, from Bear River City to Evanston, the hills on either side are occupied by the nearly horizontal beds of the Wasatch Group. The greater part of Bear river plateau is covered with a considerable thickness of these beds, which are in general rather coarser and more conglomeratic than those of the Aspen plateau. Its summit varies in width from 2 to 4 miles, beyond which to the eastward these beds are exposed in the deep canons of Woodruff, Randolph and Saleratus creeks, from 2,000 to 2,800 feet in thickness.

He found the Savory plateau region covered, principally, by horizontal beds of the North Park Tertiary, which he referred to the Pliocene, and which, as proved by exposures in the deeper cuts, on its northern edge, overlie the upturned edges of Cretaceous and earlier beds, while the higher portions of the ridges are capped by remnants of the Wyoming conglomerate. The best exposures are found in the open valleys at the heads of Savory and Jack's creeks, and on the pass between the Archaean body of the Grand Encampment mountains and the Savory plateau. A thickness of not less than 1,000 feet of these beds is here exposed, which is made up in the upper portion of a thickness of about 300 feet of a drab, earthy, somewhat porous, limestone, sometimes inclosing small pebbles, underlaid by beds, which grade off insensibly from limy sandstones into coarse gravel beds.

They occupy the valley of the North Platte to the South of Jack's creek, forming long, gentle slopes, extending up from the river to the flanks of the Grand Encampment mountain, which, though so covered by recent deposits that only few exposures of the underlying Tertiary are found, sufficiently show the continuity of their original deposition. Their beds may be traced along the line of bluffs bordering the valley of Sage creek on the south and west. Here the upper member is a hard silicious shale, more like an older rock, under which are seen the white limy sandstones ; the lower beds being concealed beneath debris accumulations.

Arnold Hague found the White River Group along the south and east face of Chalk bluffs, in Wyoming, resting unconformably upon the Laramie Group, and protruding from beneath the Pliocene beds. The strata are exposed near Carr's station, on the Denver Pacific Railroad, eastward across Owl creek, the tributaries of Crow creek, and beyond. The thickness of the group is estimated at 300 feet, and is of Miocene age.

He estimated the thickness of this Pliocene lake strata, which he called the Niobrara Pliocene exposed in Wyoming, at from 1,200 to 1,500 feet.

The beds are found lying unconformably upon the older uplifted strata, and overlapping the area of the Miocene basin. South of the Union Pacific Railroad, they occur abutting against Mesozoic formations; just north of Granite Canon, they lie next the Archaean mass; and a short distance beyond, at the mouth of Crow Creek canon, are found essentially horizontal against nearly vertical Palæozoic limestones. From Crow creek, northward, they may be seen resting directly upon every formation, from the Archæan to the Fox Hills Group.

The strata consists of marls, clays, coarse and fine sandstones, conglomerates, with some nearly pure limestones. Fine, marly sandstones are the predominant beds.

Overlying the Pliocene lake deposits on Sybille creek and its tributaries, and in the region of Chugwater and Pebble creeks, there occur beds of coarse and fine conglomerate, having a thickness of 300 or 400 feet. These beds have been called the Wyoming Conglomerate.

In North Park, Pliocene beds lie unconformably upon the older rocks, resting in places against every formation from Archæan to the top of the Cretaceous, and are seen in undisturbed condition resting against the basalts. They extend over the entire Park basin, giving it the level, prairie-like aspect, which it presents from all the higher elevations.

He referred the Tertiary beds in the eroded basins and valleys worn out in the rhyolitè in the Toyabe range of the Nevada basin, and noticable on Silver and Boone creeks to the Truckee Miocene.

S. F. Emmons found the same formation in the valley of Reese river, near Ravenswood Peak, along the foot hills, both to the east and west of the Soldier's Spring Valley basin, in the low depression of Indian valley, and in the re-entering bay north of Black Canon, with a thickness of over 700 feet.

The Truckee Miocene is so named from Truckee range, Nevada, which extends in a north and south line for 72 miles, and consists, for the greater part of the distance, of a single narrow ridge, barely more than 5 miles from base to base, but widening considerably at the southern end, where it is made up of broad fields of Tertiary eruptive rocks.

Alfred R. C. Selwyn said* that between Blackwater and Stewart's

* Geo. Sur. of Canada.

Lake, and thence to the Finlay Rapids, on Peace river, the country, with some exceptions, is more or less overspread with drift material ; much of this has been derived from the abrasion of the Tertiary formations, through which many of the principal valleys of the country have been cut, exposing alternating beds of clay, lignite, sand and rounded gravel, capped by vast sheets of volcanic products, chiefly porous and compact lavas—columnar and concretionary—and dense dolerite, forming high hills or undulating stony table-lands, such as that which is crossed by the wagon road between Clinton and Bridge creek, at an elevation of 4,000 or 5,000 feet. From Mr. Horetzky's description of the abrupt character of the country on the Susqua river, and in the vicinity of Fort Stager on the Skeena, these Tertiary volcanic products are supposed to be extensively developed in that region. The lignite-Tertiary strata which are assumed to have preceded the latest of these volcanic outbursts, occupy undefined, but extensive areas between Fort George and McLeod's lake ; and probably continue thence to the valley of Nation river, with only such interruptions as are the result, partly, of the original unevenness of the surface upon which they were laid down, and partly of the subsequent denuding agencies to which they have been subjected, giving rise to outcroppings of the older rocks, either as hills or ridges rising above the general level of the country, or appearing as rocky bars or canons in the deep-cut channels of the rivers. The general similarity of some of the sands and gravels of the drift period to those of Tertiary age, makes it difficult, without close and critical examination of each exposure, to determine to which period they should be referred, and the distribution of the drift upon the Tertiary deposits is so irregular as to make it quite impracticable to define their respective limits.

At about three miles below Nation river, a steep cliff rises on the right bank of Parsnip river, from the water's edge to 70 or 80 feet. At the base, stiff blue clays are seen, and these are overlaid by layers of sand and fine gravel, passing at the top into coarse rounded gravel. This is, probably, near the northern limit of the Parsnip river lignite-Tertiary basin, as a short distance further a rocky ridge crosses the river and crops out in both banks, the country then rising rapidly, on one side to the Rocky mountains, and on the other to the watershed between the Omineca and the Parsnip rivers. On the eastern side of the mountains there do not appear to be any deposits which can be referred with certainity to the lignite-Tertiary series. At intervals along the river, on both sides, deposits of stratified sand and gravel, cut into

benches and terraces, extend from the water to elevations of seven or eight hundred feet. Somewhat similar sands and gravels are thinly spread over many parts of the great prairie plateau, which stretches eastward from the base of the mountains. A section of these, about thirty feet thick, consisting of brown sand, and reddish rusty-looking gravel in thin bands, is seen capping the steep hill of horizontal Cretaceous shales and sandstones, which rises to an elevation of 550 feet above the river, immediately in rear of the Hudson bay post at Dunvegan. In these high gravels the pebbles are small and pretty uniform in size, in which respect they seem to differ from those of the lower benches, which are much coarser; the small and large pebbles being irregularly distributed through them. These upper gravels can not well be distinguished from those which, near Quesnel, occupy a position immediately beneath the basaltic lava flows, and perhaps they belong to the same epoch.

George M. Dawson said that along the foot of the bank of the Fraser river, in front of the town of Quesnel, a considerable thickness of the lignite-bearing formation is shown. The lowest seen is situated about a mile above the confluence of the Quesnel with the Fraser river, and consists of impure lignites and clays, with layers of soft sandstone and ironstone concretions. These are followed in ascending order by clays and arenaceous clays of pale-grayish, greenish and yellowish tints, with a general southward or southwestward dip at low angles. These fill the trough of a shallow synclinal over which the town of Quesnel stands. On the south bank of the Quesnel river, the impure lignites and associated beds rise again to the surface, and in some sections of 15 or 20 feet, the lignite may constitute 1-6th of the whole. It is not, however, in well-defined beds, but interstratified throughout with clays and appears to have been deposited in the form of drift-wood by somewhat rapidly flowing water, and is not so pure as to be of any economic importance. Small spots and drops of amber are abundant in some layers. Half a mile below the mouth of the Quesnel river, on the east bank of the Fraser, a cliff exposes about 100 feet in thickness of this lignitiferous group. The plants, from the Quesnel beds, and also from the lignitiferous beds on the Blackwater, are to a great extent identical with those described by Prof. Heer from the "Miocene" of Alaska, though the age of these beds may be and probably is older than the Miocene.

The basaltic series, consisting of several or many horizontal or overlapping flows, with the exception of those areas of older rocks protru-

ding through them, or exposed in the river valleys where they have been cut away, extend from the lower portion of the Chilcotin river westward to that part of the Chilanco due south of Puntz lake; on the Chilco, to a point a few miles west of the 104th meridian, and on the Chilcotin itself, may stretch to Chizicut lake, and thence extend north-eastward, their boundary nearly following the Clusco river for some distance. They characterize the greater part of the Nazco valley, and the plateau extending east and west from it, and probably reach the western slope of the range of hills crossing the Blackwater at the upper canon. The rocks exhibited in these flows are usually true basalts or dolerites of various textures, and from iron-gray to dark greenish and nearly black colors, and often contain much olivine. The vesicles are comparatively seldom filled with infiltrated minerals, though near the sources of the Nazco they are almost invariably so, the material being pale chalcedony, passing over in some instances to chrysopraze. In this vicinity, and near Cinderella mountain, some beds are wacke-like and scoriaceous; and the soil of the water-shed region between the Nazco and Bae-zae-coh, on the Cluscus trail, seems to be almost entirely composed of fine rusty pumiceus fragments.

Samuel H. Scudder described, from a very fine grayish and greenish-white fire-clay, in thin layers, with coniferous and angiospermous leaves and seeds, 8½ inches thick, which is superimposed upon a two-inch layer of carbonaceous clay, or impure lignite or matted leaves, mingled with clay, and succeeded by 36 feet of sands and clays, at Quesnel, the following insect remains, to-wit: *Formica arcana*, *Hypoclinia obliterata*, *Aphænogaster longæva*, *Pimpla decessa*, *P. saxea*, *P. senecta*, *Calyptites antediluvianum*, *Boletina sepulta*, *Brachypeza abita*, *B. procera*, *Trichonta dawsoni*, *Anthomyia inanimata*, *A. burgessi*, *Heteromyza senilis*, *Sciomyza revelata*, *Lithortalis picta*, *Lonchæa senescens*, *Palloptera morticina*, *Prometopia depilis* and *Lachnus petrorum*.

Robert Bell, in his report on an exploration between James bay and lakes Superior and Huron, says, that in the region about the height of land, at the head of the east branch of the Montreal river, the lower levels are filled with great mounds and steep ridges of gravel and cobble-stones. The valley of this river, for some miles before it joins the main stream, is also covered with similar materials. The first limestone pebbles were observed on the Mattagami, 24 miles below Kenogamisse Lake. Along the Missinibi river, for many miles above its junction with the Mattagami, a blue clay, only occasionally holding

pebbles, underlies the gray and drab bowlder clay, which is overlaid by gravel, sand, and gravelly earth. Marine shells were collected along this river from the Grand Rapids, and along the Missinibi from near Round bay, all the way to Moose factory. They appear to be derived from a pebbly, drab clay, associated with the bowlder drift. The greatest elevation above the sea at which they were collected, is about 300 feet, but they were found along the Kenogami, a branch of Albany river, at the height of 450 feet. Among the fossils collected are, *Rhynchonella psittacea*, *Leda truncata*, *L. pernula*, *Cardium islandicum*, *Tellina grœnlandica*, *Macoma sabulosa*, *Saxicava arctica*, *Balanus crenatus*, *Mya arenaria*, *M. truncata*, *Mytilus edulis*, and *Buccinum undatum*.

Milne and Murray* found the drift on Newfoundland containing shells similar to those still living in the surrounding sea, as well as striated angular stones, terraces, and raised beaches tending to show that Newfoundland was at no very remote period below the present level of the sea. The surface of the rocks is often roundly smoothed and striated as if produced by coast-ice acting in a rising area.

Prof. E. D. Cope† described, from the shales of the Green River Group, Wyoming, near the main line of the Wasatch mountains, *Dapedoglossus testis*, *Diplomystus dentatus*, *D. analis*, *D. pectorosus*, *Erismatopterus endlichi*, *Amphiplaga brachyptera*, *Asineops pauciradiatus*, *Mioplosus abbreviatus*, *M. labracoides*, *M. longus*, *M. beani*, *Priscacara serrata*, *P. cypha*, and *P. liops;* from the Eocene of the Rocky mountains,‡ *Clastes aganus*, *Trionyx radulus*, *T. ventricosus*, *Plastomenus serialis*, *Stypolophus hians*, *Tomitherium tutum*, *Plesiarctomys buccatus*, *Coryphodon obliquus*, *C. lobatus*, *Orotherium loewi;* from the Loup Fork Group, *Canis wheeleranus*, *Dicrocerus trilateralis*, and *D. tehuanus;* from the Eocene§ in Macon Co., Ga., *Amphiemys oxysternum;* from the Upper Miocene of Montana, *Pithecistes brevifacies*, *Brachymeryx feliceps*, *Cyclopidius simus*, *C. heterodon*, *Blastomeryx borealis;* from the Loup Fork Group of Northwestern Kansas, *Dicotyles serus*, *Tetralophodon campester;* from the Pliocene of Oregon, *Cervus fortis*, *Anchybopsis altarcus*, *A. angustarcus*, *A. gibbarcus;* from Washington Territory, *Taxidea sulcata;* from Southwestern Texas, *Pseudemys bisornatus*, *Cistudo marnochi*, *Anchybopsis breviarcus*, and *Cœnobasileus tremontigerus*.

* Geo. Mag. 2d ser., vol. iv.

† Bull. U. S. Geo. Sur. Terr., vol. iii.

‡ Wheeler's Sur. W. 100th Mer., vol. iv.

§ Proc. Am. Phil. Soc.

Prof. O. C. Marsh* described, from the Miocene of the Rocky mountain region, *Moropus distans*, *M. senex*, and *Allomys nitens;* from the Green River Group of Wyoming, *Heliobatus radians;* and from the Pliocene of the Rocky mountains, *Moropus elatus*, *Tapiravus rarus*, *Bison ferox*, *B. alleni*, and *Crocodilus solaris*.

Prof. F. B. Meek† described, from the Miocene at Cache valley, Utah, *Limnæa kingi*.

Dr. C. A. White‡ described, from the Wasatch Group at Black Buttes Station, Wyoming, *Unio provitus*, *U. holmesanus*, *U. endlichi*, *U. couesi ;* and from Wales, in Utah, and the Canon of Desolation, of Green river, *Unio mendax ;* from the Tertiary,§ at Last Bluff, Utah, *Physa pleuromatis ;* and from Joe's Valley, *Viviparus ionicus*.

In 1878, Prof. C. A. White‖ said the Wasatch Group is the lowest of a series of three fresh-water Tertiary Groups, all of which are intimately connected, not only by an evident continuity of sedimentation throughout, but also by the passage of a portion of the molluscan species from one group up into the next above. Not only were these three groups, aggregating more than a mile in thickness, evidently produced by uninterrupted sedimentation, but it seems equally evident that it was likewise uninterrupted between the Laramie and Wasatch epochs, although there was then a change from brackish to fresh waters, and a consequent change of all the species of invertebrates then inhabiting those waters.

The Wasatch Group, for which "Vermilion Creek Group" and "Bitter Creek Group" are uncalled-for synonyms, in the Green river region, consists very largely of soft, variegated bad-land sandstones, that reach a thickness of about 1,500 feet, together with from 100 to 300 feet of the ordinary indurated sandstones, alternating with bad-land material at the base, and a similar amount of similar material at top, the estimated aggregate thickness being about 2,000 feet.

Resting immediately and conformably upon the Wasatch are the strata of the Green River Group. Although intimately connected with the former by continuous sedimentation and specific identity of molluscan species, they differ considerably from those of that group in general aspect, and in composition also. The group is lithologically

* Am. Jour. Sci. and Arts, 3d ser., vol. xiv.
† U. S. Geo. Expl., 40th Parallel.
‡ Bull. U. S. Sur., vol. iii., No. 3.
§ Wheeler's Sur. W. 100th Mer., vol. iv.
‖ 10th Ann. Rep. Hayden's U. S. Geo. Sur. Terr.

separable into a lower division, having a thickness of about 900 feet, and an upper division having a thickness of about 500 feet.

The Bridger Group in the typical localities rests conformably upon the Green River Group, into which it passes without a distinct plane of demarkation among the strata. Its molluscan fossil remains correspond closely with those of the Green River Group, some of the species being common to both, all indicating a purely fresh condition of the waters in which the strata of both groups were deposited. In the valley of Red Bluff Wash, between Raven ridge and White river, where they are covered by the Brown's Park Group, the thickness is only about 100 feet.

The Brown's Park Group is unconformable with the Bridger Group, but it can not be of later date than Pliocene, for the following reasons: In many places the strata still remain in a nearly horizontal position, but in others they have been considerably displaced, as, for example, by being flexed up against the flanks of the Uinta mountains, and also, in a similar manner, against the Dry mountains, northeastward from Brown's Park. This shows that, although much movement of displacement took place before the deposition of the Brown's Park strata, as shown by their unconformity with those of the older groups, a considerable amount of movement, even of mountain elevation, has taken place since their deposition, Beside this, a large proportion of the immense denudation which the strata of that region have suffered, is known to have taken place since the deposition and partial displacement of the Brown's Park Group, because these strata are involved with the others in that denudation. Furthermore, a remarkably extensive outflow of basaltic trap, covering a large region which lies mainly to the eastward, but which formerly extended much within the limits of this district, took place after the deposition of this Group, and also after it had suffered displacement and erosion to some extent, at least. This is known to be the case, because the trap is found resting upon the unevenly eroded surface of a portion of this group, at Fortification Butte. That portion occupies a higher level than does the principal portion of the group, and the trap rests unconformably upon the Laramie and Cretaceous strata, in the immediate vicinity, as well as upon the Brown's Park strata, in such a manner as to show that little, if any, movement has taken place since the trap outflow. The denudation of the rocks of that region has been so great since the trap outflow, that the latter rock has been removed from a large part of the surface it once occupied, leaving only here and there mere shreds of the once massive and extensive sheet upon the higher hills.

The Brown's Park Group occupies that expansion of Green river valley which is known as Brown's Park. From there it extends eastward and around the eastern end of the Uinta uplift, except a few miles interruption of its continuity there, and thence extends westward along the southern base of the Uinta mountains a large part of the length of that range. It extends northward from the eastern portion of the Uinta mountains, as far as Dry mountains and Godiva ridge. Remaining patches of it show that the formation formerly extended eastward as far as the foot hills of the Park range. It occupies nearly the whole surface of the western portion of Axial basin, comparatively small areas immediately east and immediately north of Yampa mountain, and a considerable portion of the space between Junction mountain and the eastern end of the Uinta uplift, all of which spaces are in unbroken continuity. It, also, occupies a large space from Raven ridge and Red Bluff Wash extending far westward.

F. M. Endlich observed the Wasatch and Green River Groups spread over an area in the White river region of western Colorado, of more than 3,000 square miles. A section on Douglas creek, a branch of White river, showed a thicknesss of 1,500 feet for the Wasatch Group. A stratum of brick-red sandstone, 160 feet in thickness, and placed immediately below the middle of the Group, served as a landmark for identification. Inferior beds of coal occur in the upper part of the Group. Groups of columnar monuments, and monuments composed of shales with cappings of sandstones are not uncommon.

Fine exposures of the Green River Group occur in the Book Cliffs, just north of the Grand river. Geognostically and lithologically speaking, it is separable into an upper and lower division. The lower arenaceous division having a thickness of 2,400 feet, as obtained from the southern bold escarpment of the plateau, and corroborated by observations elsewhere ; and succeeded by laminated shales, having a thickness of 1,000 to 1,200 feet ; the upper division consisting of yellow and brown sandstones, with thin interstrata of dark shales, and having a thickness of 1,100 to 1,200 feet. These sandstones, by erosion and weathering, have assumed many fantastic shapes, some imitating the ruins of some ancient building, and others rising in spires for several hundred feet above their gently sloping surroundings. A group of three of these weathered monuments near Asphalt Wash, in White river valley, one of which is 80 feet high, received the name of the "Happy Family."

On the White river drainage he observed no evidence pointing to the

former existence of glaciers. The numerous canons cut through the soft shales, marls, and sandstones, are formed so regularly, and agree so thoroughly with the pronounced stratigraphical conditions, that they admit of no other agency having shaped them than water. Ascending any one of them toward the main divide, the upward slope is found very even, its valley widening wherever other creeks or streams enter, and its entire character in conformity with the view regarding it as the result of the action of flowing water.

Dr. A. C. Peale made a section of the Roan cliffs, at White Mountain, on Grand river, where he found the thickness of the Wasatch Group, measured by angles taken with the gradienter, to be 1,650 feet, and the Green River Group, 2,282 feet.

George M. Dawson* referred the lignite and basaltic series in the basins of the Blackwater, Salmon, and Nechacco rivers, and on Francois lake, in British Columbia, to one group, which, on the evidence of the fossil plants, corresponds with the Miocene of Alaska and Greenland. The basaltic and other igneous flows form the latter part of the group, but blend with the underlying sedimentary beds, and form an integral part of the whole. No trace, however, is found of rocks due to volcanic action since the period of the drift. The sources of the immense flows of molten matter have been numerous; for, beside the many dykes found traversing the older rocks, which may, at one time, have been fissures giving exit to lava streams, beds characterized by a roughly brecciated character appear in many places, and can scarcely have been formed far from the mouths of larger or smaller vents, capable of ejecting fragments. Between the region of the upper waters of the Blackwater and Salmon rivers, and the Bella Coola, three masses of broken mountains represent as many centers of former very great volcanic activity.

Samuel H. Scudder described, from the Tertiary at Quesnel, British Columbia, *Sciara deperdita*, *Euschistus antiquus*, *Lachnus quesneli*, *Bothromicromus lachlani*, and *Aranea columbiæ*.

The striæ upon the rocks of New Hampshire† are extremely variable in their course. A few extremes are as follows: S. 2° E.; S. 83° E.; S. 58° W.; N. 40° W.; N. 83° E.

Bible hill, in Claremont, rises about 350 feet above the plain of the village, at its northern base. What is supposed to be the normal direction of the striæ is about S. 12° W., which occurs commonly west of

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* Geo. Sur. of Canada.

† Geo. of N. Hampshire, vol. iii.

the summit of the hill for two or three miles, reaching beyond the Connecticut. North of the village, it is S. 15° E. ; among the houses, S. 41° E. ; and on the east side of the hill, S. 23°–25° E., in a valley leading to Unity. On the south slope of Green mountain, east of the village, are intersections of the almost east course with that of about S. 12° E. On the westerly side of the top of Bible hill, the most common course is S. 6° E., with S. 25° E. This is a half mile east from Brown's, Clark's, and Stone's, where the westerly course has been noted. We now proceed three fourths of a mile northeast to the "Flat Top," a spur of the hill, with scarcely any depression between. At the commencement, where the northeast slope begins, are striæ S. 57° E., pointing back to Little Ascutney, and crossing others S. 1° W. Next are some S. 46° E. pointing to Ascutney, apparently marked on the lee side of striæ, pointing S. 1° W. to S. 1° E. Another ledge has striæ S. 46° E. crossed by others S. 1° E.; then S. 16° E. crossed by S. 41° E., and S. 51° E., the middle one the most common. Another ledge shows, in a narrow compass, the courses S. 21°, 36°, 41°, and 57° E. Where the courses are so numerous, there is a marked tendency to irregularity ; the striæ do not preserve their parallelism. A change of 10° or 15° degrees in direction will occur in a distance of less than a yard. Flat Top hill shows more of the irregularities than the highest summit to the southwest. Near the aqueduct, at the base of Flat Top, the course is S. 17° E.

Prof. E. D. Cope* described, from the Miocene of Oregon, *Steneofiber gradatus*, *Entoptychus cavifrons*, *E. planifrons*, *E. crassiramis*, *Pleurolicus sulcifrons*, *Meniscomys hippodus*, *M. multiplicatus*, *Temnocyon altigenis*, *Canis cuspigerus*, *C. geismarianus*, *Machærodus strigidens*, *M. brachyops*, *Anchitherium equiceps*, *A. brachylophum*, *A. longicristes*, *Stylonus seversus*, *Dæodon shoshonensis*, and *Hyopotamus guyotianus*.

He described,† from the Upper Miocene of Montana, *Ticholeptus zygomaticus;* from the Loup Fork beds of Kansas, *Aphelops fossiger*, *A. malacorhinus*, and *Mylagaulus sesquipedalis ;* from the Green River Group, on Bear river, Wyoming, *Priscacara oxyprion*, *P. pealei*, *P. clivosa*, *Dapedoglossus æquipinnis ;* and from Florissant, Colorado, *Trichophanes foliarum;* from the Pliocene of Oregon, *Auchenia vitakeriana*, *Mylodon sodalis*, *Graculus macropus*, *Anser hypsibatus*, and *Cyg-*

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* Proc. Am. Phil. Soc.

† Bull. U. S. Geo. Sur. Terr., vol. iv.

nus paloregonus; and from a lacustrine, Post-pliocene deposit in Vandenburg county, Indiana, *Cariacus dolichopsis.*

Messrs. Henry F. Osborn, Wm. B. Scott, and Francis Speir, Jr.,* described, from the Eocene of Wyoming and Colorado, *Megencephalon primævus*, *Leurocephalus cultridens*, *Hyrachyus imperialis*, *H. intermedius*, *H. crassidens*, *Helaletes latidens*, *Ithygrammodon cameloides*, *Uintatherium leidyanum*, *U. princeps*, *Paramys superbus*, *Crocodilus parvus*, and *Tricophanes copei.*

J. A. Allen† described, from the insect bearing shales of Florissant Colorado, *Palæospiza bella.*

Prof. Leo Lesquereux‡ described, from the Pliocene Chalk bluffs of Nevada county, California, *Sabalites californicus*, *Betula aequalis*, *Fagus pseudo-ferruginea*, *Quercus nevadensis*, *Q. distincta*, *Q. gœpperti*, *Q. royana*, *Q. pseudolyrata*, *Castaneopsis chrysophylloides*, *Salix elliptica*, *Platanus appendiculata*, *P. dissecta*, *Liquidambar californicum*, *Ulmus californica*, *U. pseudofulva*, *Ficus sordida*, *F. tiliaefolia*, *Aralia whitneyi*, *A. angustiloba*, *Cornus kelloggi*, *Magnolia lanceolata*, *M. californica*, *Acer aequidentatum*, *Zizyphus microphyllus*, *Z. piperoides*, *Rhus mixta*, *R. myrciaefolia*, *Juglans californica*, *J. laurinea*, *J. egregia;* from Table mountain, Tuoloumne county, *Quercus elænoides*, *Q. convexa*, *Salix californica*, *Ulmus affinis*, *Ficus microphylla*, *Persea pseudo-carolinensis*, *Cornus ovalis*, *Acer bolanderi*, *Ilex prunifolia*, *Rhus typhinoides*, *R. bowenana*, *R. metopioides*, *R. dispersa*, *Cercocarpus antiquus;* and from Oregon, *Xanthoxylon diversifolium*, *Juglans oregoniana*, and *Quercus bowenana.*

Prof. W. H. Dall§ described, from the Pliocene of California, *Axinea profunda*, *Pecten expansus*, *P. hemphilli*, *P. stearnsi*, *Anomia limatula*, and *Scalaria hemphilli.*

In 1879, Dr. A. C. Peale‖ found the Wasatch Group in the Green river basin resting unconformably upon strata from the Silurian to the Laramie: along the southwestern slopes of the Wind River mountains, upon the granitic rocks; south of Thompson plateau upon the Jurassic rocks of Meridian ridge; and north of Thompson plateau on Jurassic, Cretaceous and Laramie beds. The strata along the southwestern slopes of the Wind river mountains were evidently derived

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* Pal. Rep. Princeton Sci. Exped.
† Am. Jour. Sci. and Arts, 3d ser., vol. xv.
‡ Rep. Foss. Plants Aurif. Grav. Deposits.
§ Proc. U. S. Nat. Museum.
‖ 11th Ann. Rep. U. S. Geo. Sur. Terr.

from the disintegration of the granitic rocks of the mountain range. They consist of yellow, gray, and pink sands and marls, which dip from 5° to 10° from the mountains. West of Green river the character of the beds is similar to those on the east. They are generally brick-red in color, and weather into picturesque bad-land forms. Along the edge of the basin they are composed of conglomerates which contain pebbles of limestone derived from the adjacent mountains. The red character of the strata is due to the wearing away of the red Mesozoic rocks. The thickness exposed along the western edge north of Thompson plateau is from 500 to 800 feet. On the Bear lake plateau the thickness is greater, especially toward the west, and on the eastern flanks of the Bear River range it is still greater; it increases also to the southward until it is several thousand feet in thickness. The line separating the Wasatch from the Green River Group is lithological. All the variegated beds that lie below the laminated, light-colored sandstones, are referred to the Wasatch Group, and all above to the Green River Group.

The area between Green river and the Big Sandy is covered with the Green River Group until the northern portion of the basin is reached. North of the New Fork it is present only as cappings of the mesas that stand between the streams. Along the east side of the Green, from New Fork southward, the Green river shales and sandstones form bluffs several hundred feet in height. On the west side of the river above La Barge creek, the group is present only in isolated mesas. South of that stream, however, it is the surface formation rising from Green river to the westward, and breaking off in bluffs that face Meridian ridge. It consists of a series of light colored sandstones which are succeeded by calcareous layers and fissile shales. In the Ham's Fork plateau the group forms the surface of a shallow synclinal; it is highly fossiliferous, and contains near the top a layer of bituminous shale. An excellent fossil locality may be found on Twin creek, at the South end of the Ham's Fork plateau. It was at Station 14, south of Horse creek and west of Green river, where beds of limestone were found completely covered with the petrified cases of caddis-flies described by Dr. Scudder, under the name of *Indusia calculosa.*

The Bridger Group may be observed extending northward from Ham's Fork toward Slate creek, breaking off in low bluffs, in which the sombre clays and sands of the group are exposed. Between the mouth of the Big Sandy and the Green, on the east side of the former, there are variegated sands and marls belonging to this group, which weather into bad lands.

The Pliocene or Salt Lake Group in Bear river valley consists of yellow sands and marls, white limestones and shales, and pea green shales and sands. The thickness is estimated at from 600 to 700 feet.

The Salt Lake Group or Pliocene of Cache valley is succeeded by a later Pliocene deposit, for which Dr. Peale proposed the name Cache Valley Group. The beds near the center of the valley deposited by the lakes, and still remaining in horizontal position, are those to which he applied this new name, but without more reasons than he adduces it would have been just as well not to have proposed it.

F. M. Endlich found east of the Wind River Range a series of variegated, arenaceous marls, resting upon the yellow sandstones of the Laramie Group. These are of the age of the Lower Wasatch or Lower Eocene. They are nearly horizontally stratified, and are carved into typical "Bad Lands" by fluviatile erosion. A variety of colors presents itself in these marls. Gray and reddish-brown predominate, interchanging, however, with yellow, white, greenish, and maroon. Without any apparent separation of strata, these colors and shades form bands resembling well-defined bedding. Rapidly denuded by erosion, the slopes presented by these marls are generally entirely bare of vegetation. Thin bands of highly argillaceous sandstones, occurring sporadically within the series, sometimes give rise to the formation of low regular bluffs. These marls southeast of Beaver creek, have a thickness of 450 to 500 feet. They are supposed to be parallel with the Puerco marls of New Mexico and Colorado. They are succeeded by the yellow sandstones and shales of the Upper Wasatch Group.

An extensive section of the Wasatch Group may be obtained north of Salt Wells. The lower marls reach a thickness of 600 to 700 feet, and the upper sandstones and shales attain a thickness of about 600 feet. A number of volcanic eruptions have taken place in this region. Several buttes occur, from one of which called Essex mountain, the extension of the Wasatch Group may be traced by its color. The Red Desert of this region is derived from the upper members of the Wasatch Group. Not a drop of water is to be found in this desert. The thickness of the Upper Wasatch diminishes in the direction of the Sweetwater.

The Wasatch Group is succeeded by the Green River Group. Packer's creek flows in a southerly direction into Bitter creek, a short distance east of Rock springs. West of it there is a high ridge composed of the light Green river shales. The strata have a gentle dip to

the westward. Erosion has removed large masses of the strata, and exposed the Wasatch for a number of miles up stream. Eastward the Green River makes a sharp turn and passes north of Essex mountain. In this section the lower members of the Green River Group are composed of gray and bluish shales, more or less calcareous and arenaceous. Higher up the shales are yellow and light brown, mostly very sandy, but containing strata of impure argillaceous limestones. Above these follow concretionary sandstones and shales, of yellow and rusty brown color. The former contains one very prominent horizon of silicious material, appearing in the form of chalcedony and agate. Near the base a thin seam of oolite occurs. West of Packer's creek, the total thickness of this group is from 1,700 to 1,800 feet. Of this the upper sandstones with their shales, occupy about 800 to 900 feet, and the arenaceous beds near the base, about 150 to 200 feet, which leaves an average thickness for the shales of 700 to 800 feet. Both the shales and sandstones diminish in thickness in their northern extension.

The Green River Group is succeeded by the Bridger Group in this section, wherever the bluffs rise high above the general level as on Steamboat buttes. A thickness is preserved of about 500 feet, but most of the group has been eroded. Toward the south and southwest it becomes thicker. On the northern edge of the Sweetwater plateau the Wasatch Group is succeeded by a local deposit, called the Sweetwater Group. It consists of brown, yellow and white arenaceous marls and clays, and near the top some sandstones without clearly defined stratification. It is not conformable with the Wasatch. This group has suffered greatly by erosion, but retains a thickness in some places of 1,200 to 1,400 feet. The hills south and southwest of Saint Mary's ranch, the central butte in Elkhorn Gap, the Sweetwater hills and numerous bluffs are composed of the strata of this group. It is of Miocene age.

The Sweetwater Group is succeeded by the Pliocene. Near the base it consists of a very loosely aggregated sandstone, of a light gray or yellowish color. Above this there is a succession of light marls and indurated clays. Usually these are either very light yellow or white, but pink and greenish beds are not wanting, Toward the eastern termination of the group the strata become highly silicious. Thoroughly permeated by silica, the clays become very hard and brittle. The former occurs also in the shape of narrow veins, concretions and even strata. Innumerable moss agates are strewn over about six square

miles, near Agate lakes, north of the Sweetwater. All of them are water-worn. It is an accepted fact that the "moss" in agates is but the result of impeded crystallization. The best exposures of the Pliocene series are low down on the Sweetwater, and along the northern edge of the plateau. The thickness is estimated at from 700 to 900 feet.

The Wyoming Conglomerate is structureless, and composed of the most varying material. It is the product of all formations existing within a given area. Along the entire northern slope of the Sweetwater and Seminole hills there are enormous deposits of it. The thickness is estimated at from 10 to 400 feet. It is also abundant along the southern slope of the Sweetwater mountains, in the Pliocene valley west of South Pass, and is scattered to a greater or less extent all over the country, which has been subjected to extensive erosion. The maximum accumulation occurs along the shores of the former Tertiary lakes, and was probably carried there by the waters draining into them, and it is, therefore, of the age of the younger Pliocene marls and shales.

George M. Dawson* said that in the plateau region in the southern part of British Columbia, lying east of the Coast Ranges, terraces are exhibited on a scale scarcely equaled elsewhere. They border the river valleys, are found attached to the flanks of the mountains to a great height, though none have been found in this region equal to the elevation of that on Ilgachuz mountain in the north—5,270 feet. The higher terraces can be due to nothing else than a general submergence of the country. Five of the best marked terraces on the southern slope of Iron mountain, at the mouth of the Coldwater, have the following elevations above the sea, viz: 2,386, 3,063, 3,392, 3,611, and 3,715 feet. The last mentioned is the highest observed, and is quite narrow. Above this, the drift covering becomes thinner, but rolled stones, some of them certainly from a distance, occur to the very summit—5,280 feet above the sea. The elevation of the white silt terrace bordering Okanagan lake, is 200 feet above the lake, or 1,277 feet above the sea. Leaving this to ascend the Okanagan mountain, south of the Mission, a great series of high terraces is passed over. The heights of six of these are as follows: 1,862, 2,042, 2,141, 2,645, 2,800, and 2,839 feet. On the northern slope of the same mountain, six principal terraces have the following heights: 1,451, 1,579, 1,962, 2,452, 2,553, and 2,879 feet.

* Geo. Sur. of Canada.

A hill on the east side of McDonald's river, near Nicola lake, is terraced at different levels to the height of 800 feet above the lake, or 2,600 feet above the sea. On the Coldwater, near the first bridge, a terrace fringes the west side of the valley, at the height of 200 feet above the river, or 2,955 feet above the sea. On Whipsaw creek, Similkameen river, a terrace occurs 200 feet above the stream near Powder camp, or 3,845 feet above the sea. Between Powder camp and Nine-mile creek some of the more prominent benches have the following elevations above the sea: 2,956, 3,078, 3,237, and 3,252 feet. The trail, when some distance north of the South Similkameen, above its junction with the north fork, passes over several broad terrace flats, two of these are elevated 2,632 and 2,683 feet above the sea. Near the junction of the north and south forks a terrace-flat occurs 300 feet above the river, or 2,264 feet above the sea. Further down the Similkameen, in a grassy hill above Keremeoos, a terrace is seen 1,000 feet above the river, or 2,300 feet above the sea. In a wide valley between Okanagan and Vermilion forks, a rather irregular bowldery bench occurs with an elevation of 3,713 feet. It is on the rim of the valley and far above the stream.

In the valleys of streams draining westward from the mountains, there is a remarkable absence of detrital deposits, and though a few terraces occur, the valleys are much contracted, and in a region so mountainous that it is generally difficult to decide precisely what significance attaches to them. Not only may some of them be merely river-terraces, but others may simulate beach-terraces, but owe their origin solely to the damming up of valleys by glacier ice or moraines. At the summit between the Coldwater and Coquihalla, a terrace occurs at an elevation of 3,286 feet. On the Skagit another occurs at an elevation of 1,997 feet, and on the Uztlihoos, tributary to the Anderson river, narrow but well marked benches occur at 3,087, and 3,582 feet.

Robert Bell, in his report on an exploration of the east coast of Hudson's bay, says that the striæ in the southern part of the Eastmain coast have a southwesterly course, but in going northward the direction gradually changes till it has become nearly west at Cape Jones. From this point northward the course continues west and north of west, or toward the center of the bay. The grooving is remarkably well preserved on the bare hills and on the rocks generally from Great Whale river northward. In this region one can not help being struck by the more modern appearance of the glaciated surface than in the inhab-

ited part of Canada to the south. The course of the striæ in sixty-six localities between Sherrick's Mount and Cape Dufferin vary from S. 45° W. to N. 35° W., many of them are S. 60,° 70,° or 80° W., while an equal number are N. 60,° 70,° or 80° W. The bowlder clays abound with marine shells. He found abundant evidence that the sea level is falling at a comparatively rapid rate in Hudson's bay. On the islands and shores all along the Eastmain coast the raised beaches are very conspicuous at all heights up to about three hundred feet, immediately near the sea, but, no doubt, higher ones will be found further inland. Driftwood (mostly spruce) is found almost everywhere, above the highest tides, in a more and more decayed state the higher above the sea, up to a height of at least thirty feet, and in some places up to forty and fifty feet, above which it has disappeared by the long exposure to the weather. Judging by the rate of decay of spruce-wood in this climate its preservation in large quantities, during an elevation of the land, or rather a fall in the water, to the extent of thirty feet, would indicate a change in the relative level of the sea, amounting to perhaps between five and ten feet in a century.

The striæ observed at eleven places on the east shore of Lake Winnipeg vary from S. 15° W to S. 45° W.; at thirty-four places along the boat route from Lake Winnipeg to Hudson's bay, they vary from S. 50° W. to S. 20° E.; and at twenty-one places along the Nelson river, from Great Playgreen lake downward, they vary from S. 25° W. to S. 80° W. The bearings refer to the magnetic meridian.

G. F. Mathew found the course of the grooves and scratches on the rocks in the southern counties of New Brunswick having both southeasterly and southwesterly bearings. A southeasterly course is most prevalent in the western part of Charlotte county, and a southwesterly course most prevalent in the valleys east and northeast of St. John. These two general courses, as well as the intermediate ones, are controlled by the contour of the surface of the land in the several districts where they occur; for, as a general rule, the furrows conform to the direction of the river valleys, or at least are influenced in their course by these depressions.

Prof. E. D. Cope* described, from the Truckee beds of the White River Group of Oregon, *Hesperomys nematodon*, *Sciurus vortmani*, *Paciculus insolitus*, *Canis lemur*, *Amphicyon entoptychi*, *Archælurus debilis*, *Hoplophoneus platycopis*, *Chænohyus decedens*, *Thinohyus trichænus*, *Palæochærus subæquans*, *Merycopater guiotianus*, *Coloreo-*

* Proc. Am. Phil. Soc.

don ferox, and *C. macrocephalus; Enhydrocyon stenocephalus*,* *E. basilatus*, now *Hyænocyon basilatus*, *Pœbrotherium sternbergi*, *Boochærus humerosus;* and from the Loup Fork Group of Cottonwood creek, Oregon, *Lutrictis lycopotamicus*, and *Protolabis transmontanus;* from the Green river shales of Wyoming,† *Xiphotrygon acutidens*; from the White river beds of Colorado, *Anchisodon tubifer;* and from the Post Pliocene of Shasta county, California, *Arctotherium simum.*

Samuel H. Scudder‡ described, from the thinly bedded, almost paper-like, yellow, gray siliceous Tertiary shales, on the North Fork of the Similkameen river, three miles from its mouth, *Penthetria similkameena*, *Hygrotrechus stali*, *Cercopis selwyni*, *Planophlebia gigantea*, *Cœlidia columbiana;* from Nine-mile creek, which flows into Whipsaw creek, a tributary of the Similkameen, *Trox oustaleti*, *Gallerucella picea*, *Tenebrio primigenius;* and from the Nicola river, *Nebria paleomelas*, *Cercyon (?) terrigena*, *Buprestis tertiaria*, *B. sepulta*, and *Cryptohypnus (?) terrestris.*

Prof. J. W. Dawson described, from Nine-mile creek, *Equisetum similkamense.*

In 1880, Prof. E. D. Cope§ described, from the Truckee Miocene of the John Day river, Central Oregon, *Nimravus confertus*, *N. gomphodus*, *Pogonodon brachyops; P. platycopis*, *Hoplophoneus cerebralis*, *H. strigidens*, *Dinictis cyclops;* from the Loup Fork Group of Nebraska, *Peraceras superciliosus;* and from a cave on the Schuylkill river, in Pa., of Post-pliocene age, *Smilodon gracilis.*

Dr. C. A. White‖ described, from the Wasatch Group, near the head of Soldier's Fork, Utah, *Planorbis militaris;* from the Green River Group, on Henry's Fork of Green river, Wyoming, *Planorbis æqualis*, and from three miles east of Table Rock Railroad station, *Limnæa minuscula;* and from the Upper Green River Group of Henry's Fork, Wyoming,¶ *Pupa atavuncula.*

Angelo Heilprin** described, from the Eocene of Clarke county, Alabama, *Cytherea nuttalliopsis*, *Pseudoliva scalina*, *Lævibuccinum lineatum*, *Fusus subtenuis*, *F. interstriatus*, *F. engonatus*, *F. sub-*

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* Bull. U. S. Geo. Sur. Terr., vol. v.
† Am. Nat., vol. xiii.
‡ Geo. Sur. of Canada.
§ Am. Nat., vol. xiv.
‖ Proc. U. S. Nat. Mus.
¶ 12th Rep. U. S. Geo. Sur. Terr.
** Proc. Acad. Nat. Sci.

scalarinus, *Pleurotoma moniliata*, *Pyrula multangulata*, *Solarium cupola*, *S. delphinuloides*, and *Dentalium microstria.*

In 1881, Prof. E. D. Cope* described, from beds supposed to belong to the Puerco Group, *Periptychus carinidens*, and *Deltatherium fundaminis.* From the Wind river Eocene,† *Calamodon cylindrifer*, *Esthonyx acutidens*, *Sciurus ballovianus*, *Pantolestes secans*, *Microsyops scottianus*, *Miacis canavus*, *M. brevirostris*, *Didymictis dawkinsianus*, *Ictops didelphoides*, *Bathyopsis fissidens*, *Lambdotherium brownianum*, *Hyracotherium venticolum*, and *Phenacodus trilobatus;* from the Miocene of the John Day river in Oregon, *Nimravus gomphodus*, *N. confertus*, *Coloreodon ryderanus*, *Palæochœrus platyops*, *Protolabis prehensilis*, and *Eumys lockingtonianus;* and from the Amyzon shales in the South Park of Colorada, of Upper Eocene or Lower Miocene age, *Charadrius sheppardanus.*

We have passed, in historical review, the Tertiary as it has been discovered, and is now known on the eastern, southern, and western parts of the continent of North America, leaving for further consideration, only the drift or fresh-water Pliocene and Post-pliocene of the central part. The reason for separating the rocks in this manner may be found in the fact that there is no connection between the marine drift of the New England States and northeastern shore of the continent, and the fresh-water drift or lake drift of the central part, and as to the western part or Rocky mountain region, it has never been subjected to any general drift action, though here and there the waters from the local lakes have left their drift in and about the streams that drained them.

It may be important here to remark, that in this historical review, geologically speaking, we have not found any Glacial Period or Glacial Epoch, nor palæontologically speaking, have we found any evidence whatever of such a period, nor have we found any phenomenon requiring the intervention of such a period to explain it; but, on the contrary, all the phenomena are to be accounted for, without change of climate, and without the violation of any of the laws of nature, which are now in operation, and form the basis, from which the geologist judges of the past. And when we come to a review of the drift of the central part of the continent, it will appear equally as clear that no part of it was the result of glaciers, and that so far as North America is concerned, the so-called Glacial Period never had an existence.

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* Am. Nat., vol. xv.

† Bull. U. S. Geo. Sur., vol. vi.

Before we proceed, however, with the fresh-water or lake drift of the central region, it may be proper to recapitulate some of the facts, which we have already considered, and to call further attention to the total absence of evidence to support the theory of a Glacial Period.

The marine Eocene, commencing in New Jersey, with a thickness of only 37 feet, and covering but a narrow surface area, crosses the State of Maryland at Fort Washington; Virginia, by the way of Fredericksburg, Richmond and Petersburg ; North Carolina, by way of Newbern and Wilmington; South Carolina, by way of Charleston and Shell Bluff, on the Savannah river; Georgia, by way of Milledgeville; Alabama, by way of Claiborne; and Mississippi, by way of Jackson and Vicksburg. In South Carolina, it covers a large area, and attains a thickness of 1,000 or 1,100 feet. In its surface expansion, it is exposed in Florida, and reaches up into Tennessee, where it is called the Porter's Creek Group and Orange Sand, and attains a thickness of between 800 and 900 feet. In Alabama and Mississippi, it is subdivided into the Vicksburg Group, Red Bluff Group, Jackson Group, Claiborne Group, Buhrstone Group, and Flat Woods and Lagrange Lignitic Group, and covers a large area, and attains a thickness of 872 feet. It crosses Louisiana, and offers numerous exposures in Texas. It also appears in limited exposures in California. But nowhere is it conformable with the underlying rocks. It is extremely fossiliferous in many of its exposures, and the general *facies* of the shells has a striking generic resemblance to the living mollusca of the same latitude, though none of the species are supposed to have survived.

The marine Miocene, beginning at Martha's Vineyard, though it may exist as far north as the State of Maine, crosses New Jersey through Cumberland county, and forms a border upon the east and south of the Eocene exposures, a large part of the way to the Mississippi river, and west across the States of Louisiana and Texas. It is not conformable with the Eocene, and in some parts does not, therefore, intervene between it and later deposits, as in South Carolina for instance its very existence has been doubted. But on the western coast, and especially in California, it is highly developed. Between Canada de las Uvas and Solidad Pass the thickness is 2,500 feet, and in other places the maximum is evidently much greater. The Coast range is composed in large part of strata of this age, and hence its elevation has been since the Miocene period. As far as we may be able to judge of the climate and temperature of this period, by the fossils obtained from this region, it was the same that it is now; and, indeed, we might go far anterior to

this for the same climate except so far as the proportion of the land and water surface may have acted to change it. It, too, is highly fossiliferous in some of its exposures, and the shells, generally, belong to living genera and many of the species still survive in the waters bordering the adjacent coast.

The marine Pliocene strata are found in Maryland, superimposed upon the Miocene, and in South Carolina upon the Eocene, and, generally, forming a narrow border at the east of these outcrops on the Atlantic coast and a wider border on the south adjoining the Gulf coast. Fossil shells of species now living on the adjacent coast abound intermingled with those which have become extinct. The number of living species indicates, so far as one may be capable of judging, identically the same climate on the eastern coast of the United States that now prevails, substantially the same may be said of the Pliocene of the Pacific coast, and especially of the California strata of this age and the living and extinct species. Indeed, there is no palæontological evidence that the Pliocene climate was different from the present, on this continent, nor could we reasonably suppose it to have been different, because the outlines of the continent were nearly the same as they are now. The Pliocene so graduates into the Post-pliocene at many places that the separation of the two is very difficult, and in others it is wholly impracticable, and, in such cases, an arbitrary approximating line for separation is assumed.

The marine Post-pliocene of the eastern coast, south of the State of New York, and bordering the Atlantic and the Gulf, and also on the Pacific coast, is usually found conformable with the Pliocene below, and always graduating into the present or modern times without a break stratigraphically or palæontologically. In South Carolina it forms a belt along the coast 8 or 9 miles wide, and the fossils nearly all belong to living species now inhabiting the coast. There are, in layers of blue mud, and also in the sands which succeed them of this age, the bones of horses, hogs, dogs, rabbits, beavers, tapirs, and other mammals that flourished, as far as we can judge, throughout the period. Here rests the evidence that the climate of South Carolina, during the Post-pliocene, was substantially the same that it is at present, and it seems to be conclusive, in the absence of any geological evidence to the contrary. The stratigraphical indications of the Post-pliocene of Texas and California, and the palæontological evidences, without a single exception, are that there has been no change in the climate of these States since the Pliocene age. That man was

an inhabitant of this continent during part or all of the Post-pliocene period, no reasonable man will doubt, for his bones and his stone implements have frequently been found in the Ashley beds of South Carolina, with the remains of the extinct Mastodon and Mammoth, and living mammals that are well known to have been contemporaneous. This mixture of the bones and implements of man, with the remains of living and extinct mammals, is also well known from the labors of Prof. Whitney, in California.

Sometime during the Pliocene or Post-pliocene era, and, most likely, commencing during the first and continuing into the second, a portion of the northeastern coast, about Hudson's Bay, and the Gulf of St. Lawrence, and that arm of land south of the Gulf, and east of Lake Champlain and the Hudson river, known as New Brunswick and the New England States, was submerged or overflowed by ocean currents, with the exception of a few mountain elevations. The depression in the Hudson Bay region has been fully set forth in the foregoing pages. It appears that the rocks are striated in nearly all directions, and that upon the striated surface there rest marine clays full of fossils belonging to the living species of that region, and numerous bowlders from the contiguous mountains and hills. The scratches are evidently the work of floating icebergs and shore ice, during the period of submergence. There is no general radiation of detritus from mountain ranges to evidence the existence of glaciers in this region, nor any other evidence tending to show that the climate was materially different from what it is now. The fossiliferous marine clays and sands prove the submergence, and all other phenomena, including the scratches, follow as the necessary results of submergence, in that latitude, without the intervention of glaciers; and, furthermore, there is nothing to warrant the supposition of a glacial period within this area. And as the Laurentian range of mountains is south and east of this submerged area, and rises to the height, in some places, of 3,000 to 4,000 feet, and generally has an elevation of 1,500 feet or more above the level of the ocean, no reasonable theorist will claim that a glacier would ascend this range of mountains for the mere purpose of going south, and yet how could we have a continental sheet of ice moving south unless it did. Modern ice has a tendency to move down an incline, rather than to ascend rugged elevations and mountain chains, and an ordinary philosopher would suggest, that if we must have a Post-pliocene glacier, on the northern side of the Laurentian mountains, that we let it slip down hill instead of up, even if the

direction is to the north. Of course this would destroy much of the beauty and symmetry of the glacial theory, but there would be one thing in its favor—it would not be reversing the laws of nature.

South of the Laurentide mountains, the surface of the rocks beneath the bowlder clay is generally striated in the direction of the valleys. This pursuit of the valleys by the lines of striation may be observed from the mouth of the Gulf of St. Lawrence up the St. Lawrence, and down the Champlain and Hudson river valleys. No one who has read the description of these markings by Prof. Dawson can have any doubt that the bodies which produced them came from the Atlantic ocean at the eastern end of the Laurentian range of mountains, and following up the St. Lawrence were drifted to the south at various angles, some floating over New Brunswick, and others over Maine, and others passing up so far as to drift through Lake Champlain, and re-enter the Atlantic ocean by the Hudson river, while others drifted past Montreal, and were driven into the mouth of the Ottawa river valley, and the ancient valley of Ontario.

In New Brunswick, which is immediately south of the gulf, the striæ are related to the contour of the surface of the land, and conform to the direction of the river valleys. A southeasterly course prevails in the western part of Charlotte county, and a southwestern course in the valleys east and northeast of St. John. A map of the State of Maine, showing the course of the rivers will show the course of the striæ. The appearance of the surface geology of this State early suggested the fact that a great rush of waters poured over it from a northerly source, and transported, by its power, the surface debris which had accumulated in earlier ages by subærial forces, and large masses of rock from parent ledges, and deposited them in regions more or less distant from the several sources, and as they passed along they striated and grooved the rocks against which they impinged, or over which they rubbed in the traveled course. The course of the striæ is, therefore, in nearly all directions. If the rivers are flowing in valleys, bearing to the southeast, the striæ have that course, or if south or southwest, the striæ conform to the valley. Sometimes striæ have been found which ultimately varied at right angles from their original direction. The Katahdin mountains formed an obstruction around which the striating agency operated, but it did not cross the summit. The striæ are found upon the north side of the mountains, and not upon the south side, unless for a short distance where the slope is small. The striæ in the States of Vermont and New Hampshire are in all directions, and it is

with difficulty that any two sets are found exactly agreeing in their course, though as in Maine they conform to the direction of the valleys. The greater part of Massachusetts and Connecticut is covered with the drift sand, gravel, bowlders or clay, and the grooves, furrows and scratches upon the surface of the rocks in place, have a general southerly direction, though varying with the contour of the valleys to a southeasterly or southwesterly course. At the Island of New York, there is abundant evidence that a current swept over it from the northwest to the southeast. The furrows are most strongly marked on the northwestern slopes of the hills, and least so on the southeastern. In many instances they are very distinct on the western and northwestern slopes, extending to the highest points of the rock, but no traces are to be seen on the eastern and southeastern slopes, although both slopes are equally exposed. The striæ are most numerous in the middle part of the island, somewhat less in the western, and least in the eastern. It appears that the current was deflected southward by some force, at an angle to its course in the middle part of the island. Throughout all this region south of the Gulf of St. Lawrence, and the St. Lawrence valley, we have in the course of the striæ, and the distribution of clay, sand, gravel, and bowlders, the evidence of an overflow of the whole country, except the higher hills and mountains, and the evidence that this overflow was by subsidence of the coast, and that the Arctic current, instead of leaving the coast on approaching the mouth of the Gulf, as it does now, flowed into the Gulf and across the depressed New England area, transporting its fields of ice, which grounded upon the northern slopes of hills and mountains, and rubbed the rocks in the valleys and plains wherever the surface soil and subærial accumulations were swept off by the grinding weight of a mass driven by a current through water too shallow to float it. However, the evidence of submergence does not rest alone upon these appearances, but stands upon the incontestible ground of palæontology.

Throughout nearly all this region the striated rocks are succeeded by fossiliferous, bowlder-bearing, marine clays and sands. In the Gaspe peninsula ocean terraces and stratified clay containing marine testacea occur at the height of 600 feet above the sea. In the St. Lawrence valley, the valley of the Ottawa, Champlain region of Vermont, and over the triangular area of 9,000 square miles extending from Ottawa to Lake Champlain, the marine fossils occur in the bowlder clay at all elevations as high as 500 feet or more above the level of the ocean. The fossiliferous marine clays and sands form a

coating for a large part of the face of New Brunswick, and sea beaches, sea bottoms, and fossiliferous clays form almost a continuous belt on the coast of Maine, 150 feet above the ocean, and extending up the rivers to the same height. These facts prove the submergence of the country, beyond a doubt, to a depth much greater than 600 feet below the present level of the ocean; because the marine shells must have some depth of water as well as the clay, in which to encase them, in order to produce fossilization. Nor would we expect, on account of the ocean currents that swept over the region in question, to find marine remains, except in very deep water, where the shells or bones might receive a covering of drift materials sufficient to preserve them from the disintegrating and denuding agencies which have prevailed, during the long train of centuries that have elapsed since the deposit.

The nodules at Green's creek are in the lower part of the Leda clay, which contains bowlders, and is succeeded by very large bowlders, while no bowlder clay underlies it. The plants contained in these nodules are characterized as a selection from the present Canadian flora of some of the more hardy species, having the most northern range, and the animals such as may now be found in the Arctic current and the Gulf of St. Lawrence. It appears, that the Arctic current, that entered by the way of the Gulf of St. Lawrence, backed its waters up the Ottawa valley, and that the plants from the heights of the Laurentian range of mountains, on the border of the valley, found their way into an eddy, where the blue clay was precipitated, and the *Mallotus villosus*, molluscan shells and hardy vegetation were so beautifully coffined in enduring nodules of stone. Dr. Dawson collected and identified from the marine deposits ten species of plants, and 195 species of radiates, molluscs, articulates, and vertebrates, and the whole of these, with three or four exceptions, he affirmed to be living northern or Arctic species, belonging, in the case of the marine species, to moderate depths, or varying from the littoral zone to 200 fathoms. The assemblage is identical with that of the northern part of the Gulf of St. Lawrence and Labrador coast, at present, and there is nothing in it to indicate any change of climate, beyond that which would necessarily follow, by changing the Arctic current, so as to throw it into the gulf and across the New England States.

There is nothing in all this area that indicates the existence of even a local glacier with any degree of certainty, though it may not be considered impossible that a small glacier should have existed upon the top of some of the highest mountain peaks of New England, when

the Arctic current was flowing across the lower land. There is nothing to indicate a glacial period, but, on the contrary, every known geological and palæontological fact tells us that it never existed. And in the face of all these evidences furnished by scientific investigation, without the intervention of any extraordinary or unusual exercise of the powers of nature, except the depression and elevation of a coast line, which is proven by the deposit of the shells and bones of marine animals, it is difficult to understand how any one can conceive of a continental sheet of ice rising up from Hudson's bay, crossing over the Laurentian mountains, going down to the depths of the Gulf of St. Lawrence, and then ascending the mountains of Maine, New Hampshire, and Vermont, for no other purpose than that of taking a trip south; and if the imagination extends that far, it is still more incomprehensible why any one should believe it.

The submergence and elevation of this margin may have included the whole of the Pliocene, and part of the Post-pliocene periods, for the vegetable remains, in the peat beds of Brandon, Vermont, and in Nova Scotia, and other places which were covered by the drift, and evidently mark the age next preceding it, have been doubtfully identified with both the Eocene and Miocene, and other palæontological evidence is wanting, except so far as furnished by the Post-pliocene, and probably Pliocene fossils enclosed within the drift itself.

The submergence and elevation of this coast, preceded the lake drift of the central part of the continent, or at least could not have been contemporaneous with it, as will be shown in the sequel. Lake Ontario is an old river channel with the adjacent low lands covered with water. It is about 245 feet above the ocean. It will be readily seen that with the coast submerged this lake would fall at the east end 245 feet, which would bring it within less than one third of its present dimensions, and leave the maximum depth of the channel less than 500 feet. And with the elevation of the coast, as there is no canon to the sea, the elevation of the lake would follow to its present level. The consideration of this subject, however, belongs to succeeding pages, and we will now pass to a brief summary of the Tertiary of the Rocky mountain region or western part of the continent.

The gradual elevation of the western ranges of mountains through the later Cretaceous and all of the Tertiary time, and the formation of bays and arms of the sea and lakes, which have drained themselves more or less completely, and yet in ever continuing succession, have made it possible for the geologist to link the Tertiary with the

Cretaceous, and to bind the Eocene, the Miocene and Pliocene with the present as one connected age. The lower Eocene lake deposits are found superimposed conformably upon the brackish deposits of the Fort Union Group. The Eocene is divided in ascending order, into the Wasatch, Green river and Bridger Groups, though these are found conformable with each other in some places and mark a continuing age. The Wasatch is again divided by having the lower marls called the Puerco Group, and the Green River Group is divided, for convenience, in some places, into an upper and lower Green River Group. It would seem that all other names proposed for the fresh-water Eocene deposits are synonyms, though the equivalency of strata has not, probably, in all cases, been determined. The Miocene is known in the lower part as the Wind River Group, and higher as the White River Group, and sometimes the latter name is used to the exclusion of the former. In some places the upper Miocene is called the Truckee Group. The Brown's Park Group, Sweetwater Group and Monument Creek Group are Miocene, but their exact position is not so fully determined. The two latter are supposed to be equivalent to part of the White River Group, and the former may be so too. The Pliocene is very properly called the Loup Fork Group. It has also, in part, received the name of the Salt Lake Group, and a conglomerate of the age of the upper part of the Pliocene is called the Wyoming Conglomerate. The distribution of these Groups and questions of synonymy, have been considered at some length, in preceding pages, and in the near future the nomenclature will no doubt be more definitely established.

The northern drift does not occur in California, nor on the Pacific coast as far north as British Columbia and Alaska. There are no indications throughout the Rocky mountain region of any general ice action. There are no such exhibitions of scratched and grooved rocks succeeded by fossiliferous marine clays and sands with bowlders, as occur in the New England States and St. Lawrence region, nor of scratched rocks and ancient soils succeeded by clay, sand and gravel with bowlders, as occur in the central part of the continent; but, on the contrary, the whole region may be regarded as an absolutely driftless area, except as to local drift produced upon the shores of the Tertiary lakes, and more or less distributed by the rivers, that in the course of time cut out the canons which drained them. On the borders of the ancient lakes, on the borders of the ancient lake-like expansions of the rivers, and on the borders of the ancient rivers, there are terraces which mark old shore lines at various places from Mexico to Alaska, and especially

throughout British Columbia. These terraces show only the ordinary subærial denudation since they constituted the shore lines of lakes and rivers; but they are standing monuments of evidence to disprove the existence of a glacial period on this continent, or the existence of a continental ice sheet; for no one can conceive of the movement of such a heavy body of ice across a valley, without disturbing the graveled terraces that border it, upon both sides, at different elevations. The natural towers that stand as an evidence of erosion from the Wasatch times to the present; from the Green River Eocene to the present; from the Bridger Eocene to the present; from the White River Miocene to the present; the columnar masses, irregular pyramids, sandstone towers, and turreted outliers of the Bad Lands of Colorado, Wyoming, Montana and British Columbia; the monuments on Monument creek; the Garden of the Gods; the buttes in all the mountain chains; the transverse ridges, lone mountains and exalted peaks; and the whole array of canons from Texas and Mexico to Alaska, all alike, tell us, in language unmistakable, that no glacial sheet ever moved south upon the western plains or mountain ranges. No geologist has ever found a rock or bowlder that had crossed the dividing ridge from one valley to another in all this western region of the United States and British America. No one has ever found any evidence of any general drift action, or general ice action in any part of the territory. Then, why talk about a continental ice sheet or glacial period ?

Many of the phenomena attributed by glacialists to a continental sheet of ice belong to the ordinary eroding atmospheric causes, others to drifting sand, others to land slides, others to land slips or avalanches, which have been precipitated into the bed of the river, producing a dam that backed the water up until a lake was formed, and the quantity of water became so great as to force its way through the barrier, and cast the increased volume with terrific force upon the valley below. Lyell notices the devastating effects of one of these land slips from the White mountains of New Hampshire, into the Saco river, in 1826, and points out its insignificance, when compared with those occasioned by earthquakes, when the boundary hills, for miles in length, are thrown down into the hollow of a valley. The effects of even extraordinary floods, in river valleys, seem to be overlooked by some glacialists; and, in this connection, it will not be without interest to call attention to one that happened in the Connecticut.

In the winter of 1780,* well known for being one of the severest ever

* Hayden's Geological Essays.

experienced in this country, the ice in the Connecticut river was increased to a great thickness and solidity. In many instances, the water in the river was literally frozen to the bottom. In the month of January, as usual, there came a great and sudden thaw, accompanied with incessant torrents of rain, which appeared to spread over an immense extent of country. The consequences were such as might be expected; the snow which was over five feet deep,was quickly melted; every stream as suddenly became a river; and every river threatened to become an ocean. The Connecticut river was very soon raised almost to a level with its banks, and the ice, which was two and a half feet thick was borne away by the current in the most terrific majesty; for whereever it was impeded in its progress, by an island, or the narrowing of the shores of the river, it was broken up, and immense masses raised into the air, until their elevated portions, preponderating over their floating foundations, were left to fall on the surrounding ice with a report, equal in some instances to that of small pieces of ordnance. This scene of awful grandeur was extended for miles to the north and south, and while thousands were contemplating the frightful spectacle, the ice, being very solid, and hurried on by a powerful current became obstructed at the mouth of the straits twenty-five miles below, near Middletown, and the whole force of the river for a short time was impeded: the water set back and upward, and enormous masses of ice were hurried over the banks of the river, into the creeks and larger streams to a considerable distance from the river, into the meadows and low grounds: When on a sudden, from the pressure above, the obstruction at the straits gave way, and this threatening appearance almost in a minute vanished; the water fell to its natural state, and left huge masses of transparent ice in the meadows and intervals, to be reremoved only by the powerful influence of a summer's sun. When this was accomplished, in the following season, large pieces of rocks and heaps of rolled pebbles were left exposed to view on an alluvial surface, on which before a stone could not be found for its weight in gold. These rocks and stones, from their characters, were known to be the same as those which composed the bed of the river many leagues above.

[To be Continued.]

FIELD NOTES ON LOUISIANA BIRDS.

By Dr. F. W. Langdon.

The following "notes" comprise a record of ornithological observations and collections made by the writer during the month ending April 17th, 1881, at "Cinclare" plantation, situated in the parish of West Baton Rouge, Louisiana, on the right bank of the Mississippi, one hundred and twenty-seven miles by river above New Orleans. A few notes made at various other points along the Mississippi and Ohio rivers are included.

The landscape at the above-mentioned locality, as elsewhere along the "Sugar-coast," is flat and uninteresting, its monotony being considerably relieved, however, by the extensive plantations now in a high state of cultivation, which, with their numerous and usually well-kept buildings, lend an air of activity and prosperity to the scene. The cultivated grounds are mainly comprised in a strip ranging from one to three miles in width, along the rivers and principal bayous, the remainder of the State being chiefly occupied by extensive forests and swamp lands. The rich alluvial loam of the agricultural districts above referred to, and the heavy growth of cypress, swamp oak, sweet gum, ash, etc., in the adjoining swamp lands, are noticeable features in contrast with the red soil and "pine-barrens" of the higher grounds and more eastern Gulf States.

Although no opportunity of adding to the present list was neglected, field observations being made almost daily during the above-mentioned period, the number of species obtained was not nearly so large as might have been expected. It seems to the writer, however, that the list is of quite as much interest for what it does *not* include, as for what it *does*, the absence of the Catbird, Long-billed Marsh Wren, Black-and-White Creeper, Yellow-rumped Warbler, White-browed Yellow-throat, Black-throated Green and Palm Warblers, Large-billed Water Thrush, Kentucky Warbler, Redstart, Song Sparrow, Pewee and some other species, being noteworthy in view of the generally received ideas of their distribution. The non-occurrence of these migratory species would seem to be of interest as furnishing a clue to the distance from the gulf, at which their lines of migration diverge and converge to and from Florida and Mexico, respectively. The Warblers above mentioned, it will be observed, are chiefly those which are found with the main body of migratory *Sylvicolidæ* further north, and

the absence of so many of the commoner species at the locality under consideration, would seem to indicate the existence of two divisions, which, migrating by different routes, join their forces higher up in the Mississippi valley. Dates of arrival and departure are given when observed; where no date is mentioned the species is understood to have been present during the entire period named.

Due allowance should be made for the exceptional character of the season, the previous winter having been unusually severe, and cultivated crops being from four to six weeks backward.

For various facilities and conveniences enjoyed during the trip, the writer is under especial obligations to Mr. James H. Laws, the hospitable proprietor of "Cinclare" and "Silvery" Plantations; acknowledgments are also due to Mr. Charles S. Burns and family, and Mr. George Collins of "Cinclare"; as well as to Mr. Joseph Collins and family, of "Silvery," for various courtesies received at their hands during his visit.

The nomenclature is that of the Smithsonian List of 1879.*

List of Species.

Family Turdidæ: *Thrushes.*

1. Hylocichla mustelina, Baird.—*Wood Thrush.*—First observed April 5th; none noted after the 11th.

2. Hylocichla unalascæ pallasi, Ridgway.—*Hermit Thrush.*—Frequented the thickets in limited numbers from March 26 to April 8.

3. Merula migratoria, Sw. and Rich.—*American Robin.*—None observed during our visit, but it is said to be a common winter resident, departing for the north in large flocks some time in February.

4. Mimus polyglottus, Boie.—*Mocking Bird.*—One of the most common and familiar birds of the locality, frequenting the fences, trees and shrubbery about houses and cultivated grounds, and never penetrating for any distance into heavy timber. By the first of April they were in full song, and quite a difference in quality was noticeable in the notes of different individuals. In addition to their ordinary song and their familiar mimicry of other species, they possess an extremely disagreeable rasping note, which they utter when quarreling amongst themselves or driving away intruders from the vicinity of their nests. Indeed they are quite as notorious for their quarrelsome and belligerent

* Nomenclature | of | North American Birds | chiefly contained in the | United States National Museum. | by | Robert Ridgway. | — | Washington: | Government Printing office. | 1881.

disposition as for their song, and it is said to be nothing unusual for them to alight on and peck at the heads of children who may approach the vicinity of their nests containing young.

A pair observed April 10, were engaged in building a nest in a "Pin Oak," about 25 feet from the ground; the male being occupied carrying materials, while the female busied herself arranging them and putting in the finishing touches by spinning around as though set on a pivot. This nest, although apparently finished before my departure on April 17, contained no eggs on that date.

5. Harporhynchus rufus, Cabanis.—*Brown Thrasher.*—Common in woodland thickets from March 30 to April 15.

Family Saxicolidæ : *Bluebirds, etc.*

6. Sialia sialis, Haldeman.—*Bluebird.*—Rather common about houses. Four fresh eggs taken March 23d from a cavity in an old snag.

Family Sylviidæ: *Sylvias.*

7. Polioptila cærulea, Sclater.—*Blue-gray Gnatcatcher.* — First observed March 29th, after which date it was common in the shade trees about houses as well as in the more open woods.

8. Regulus calendula, Licht.—*Ruby-crowned Kinglet.*—Not common; a few observed March 25 and for a few days following.

Family Paridæ: *Titmice.*

9. Lophophanes bicolor, Bp.—*Tufted Titmouse.*—A few specimens observed during March and April.

10. Parus carolinensis, Aud.—*Carolina Chickadee.*—Several specimens observed, though it could hardly be called a common species. Those shot did not differ appreciably from Ohio specimens.

Family Troglodytidæ: *Wrens.*

11. Thryothorus ludovicianus, Bp.—*Carolina Wren.*—A common species, its loud, clear notes being heard almost continually in the swamps and thickets.

Family Motacillidæ: *Wagtails.*

12. Anthus ludovicianus, Licht.—*American Titlark.*—Very common about the cane fields and pastures from March 28th until April

12th, after which time they become less numerous. Specimens taken on the latter date had began to assume the pinkish-buff of the breeding plumage.

Family Sylvicolidæ: *American Warblers.*

13. Parula americana, Bp.—*Blue Yellow-backed Warbler.*—An exceedingly common species after March 25th, frequenting the thickets and woodland about the borders of plantations, being seldom seen farther than thirty feet from the ground. It gave utterance at times, to a faint "tchip," but its song, which is heard throughout the day might be mistaken for that of the Cerulean Warbler, possessing, however, a tinge of the "*wheezy*" character of the note of *Helminthophaga pinus.* By the 15th of April their numbers had perceptibly diminished.

14. Dendrœca æstiva, Baird.—*Summer Yellow Bird.*—Common in the willows and shrubbery about open grounds. April 10th to 15th.

15. Dendrœca cærulea, Baird.—*Cerulean Warbler.*—Present in limited numbers from April 14th to April 17th.

16. Geothlypis trichas, Cabanis. — *Maryland Yellow-throat.*—Abundant in the thickets and weedpatches along canal and ditch banks from March 25 until our departure.

17. Icteria virens, Baird.—*Yellow-breasted Chat.*—First observed April 15th.

18. Myiodioctes mitratus, Aud.—*Hooded Warbler.*—First taken March 30, after which it was several times observed in swampy thickets, keeping near the ground.

Family Vireonidæ: *Vireos or Greenlets.*

19. Vireosylvia olivacea, Bp.—*Red-eyed Vireo.* A few only observed, the species being evidently much less common here than in Ohio. First taken March 30th and still present April 15th.

20. Vireo noveboracensis, Bp.—*White-eyed Vireo.*—An exceedingly common species in the woods and thickets bordering plantations, its unique notes being heard throughout the day so incessantly as to become tiresome.

Family Laniidæ: *Shrikes.*

21. Lanius ludovicianus, Linn. — *Loggerhead Shrike.* —Several specimens observed, showing their usual partiality for "Thorn" trees. A female taken March 23, shows a quite evident tendency to transverse waving of the ashy-grey of the pectoral region.

Family Hirundinidæ: *Swallows.*

22. Progne subis, Baird.—*Purple Martin.*—First observed March 22d, and after that daily until our departure.

23. Petrochelidon lunifrons, Lawr.—*Cliff Swallow.*—First noted April 15th.

24. Hirundo erythrogastra, Bodd.—*Barn Swallow.*—Present from April 12th until our departure April 17th.

25. Tachycineta bicolor, Cabanis.—*White-bellied Swallow.*—Common migrant along the Mississippi from March 20th to 30th.

26. Stelgidopteryx serripennis, Baird.—*Rough-winged Swallow.*—Arrived about March 22d. Probably remains to breed, as specimens were observed daily during the remainder of our stay.

Family Fringillidæ: *Finches, Sparrows, etc.*

27. Passerculus sandwichensis savanna, Ridgway.—*Savannah Sparrow.*—Abundant during the entire period of our visit, skulking about, almost under one's feet, between the cane rows or along the river bank amongst the scanty vegetation of the batture* and levee. Passes, in common with several other species, under the local name "Te-tese," which, among the Creoles, is synonymous with our northern term "Chippy," as applied indiscriminately to all the smaller brownish-colored birds.

28. Zonotrichia albicollis, Bp.—*White-throated Sparrow.*—An abundant migrant, keeping exclusively about the borders of swampy woodland. Still present in considerable numbers April 17.

29. Melospiza palustris, Baird.—*Swamp Sparrow.*—A very abundant species, frequenting the plantation ditches and swampy-woodland thickets. The finding of a specimen in the stomach of a Chuck-wills-widow is mentioned under the head of the latter species.

30. Pipilo erythrophthalmus, Vieillot.—*Towhee; Chewink.*—Found rather commonly in its usual haunts.

31. Cardinalis virginianus, Bp.—*Cardinal Grosbeak.*—Common about the cultivated grounds, finding shelter and attractive breeding resorts in the extensive hedges of "Cherokee Rose," which border many plantations.

32. Passerina cyanea, Gray.—*Indigo Bunting.*—First observed April 4th, in limited numbers. Became more common within the next

* Space between the levee and the river bank proper, varying in width from a few feet to a hundred yards or more.

few days, until by the 10th they were quite as numerous as in Southern Ohio during the summer.

33. Passerina ciris, Gray. — *Painted Bunting; Nonpareil.* — A male taken April 11, was the first specimen observed, and the only one seen on that day. They soon became quite common, however, so that by the 15th they were to be seen everywhere about open grounds, frequenting the fences, weed-patches and pastures, in company with Indigo Birds and the Savannah and Swamp Sparrows.

Family Icteridæ: *Orioles.*

34. Molothrus ater, Gray.—*Cowbird.*—Small flock observed March 30th, evidently migrating.

35. Agelæus phœniceus, Vieillot.—*Red-and-buff-shouldered Blackbird.*—Common about the usual places.

36. Sturnella magna. — Swainson.—*Meadow Lark.* — Common.

37. Icterus spurius, Bp.—*Orchard Oriole.*—Arrived April 5th, and by the 9th had become very common in the shade trees about houses and in the willows bordering ditches and canals.

38. Scolecophagus ferrugineus, Swainson.—*Rusty Blackbird.*—A few specimens seen in the latter part of March.

39. Quiscalus purpureus, Licht. — *Purple Grakle.* — A common species during our stay; apparently breeding April 1st to 15th. A few specimens, evidently residents, shot for purposes of identification, proved to be of the *purpureus* form, thus considerably extending the known area of its distribution.

Family Corvidæ: *Crows, Jays, etc.*

40. Corvus frugivorus, Bartram.—*Common Crow.*—A familiar species about plantations, frequenting the ditches in search of cray-fish, which are very abundant. Nest containing young observed April 30th.

The Crows all along the Mississippi have a habit of following steam-boats in squads of six or eight about meal times, evidently with a view to picking up "scraps" from the kitchen.

41. Cyanocitta cristata, Strickl.—*Blue Jay.*—Rather common about open woods.

Family Tyrannidæ: *Tyrant Flycatchers.*

42. Tyrannius carolinensis, Temminck.—*Kingbird; Bee Martin.*

—First observed March 26, after which date it was frequently seen in the usual places.

43. Myiarchus crinitus, Cabanis.—*Great Crested Flycatcher.*—First noted April 8th and occasionally afterward until the 14th.

44. Contopus virens, Cab.—*Wood Pewee.*—First observed April 14th.

45. Empidonax minimus, Baird.—*Least Flycatcher.*—April 16th, in thickets about open grounds.

Family Trochilidæ: *Humming Birds.*

46. Trochilus colubris, Linn.—*Ruby-throated Humming-bird.*—First observed March 31, after which it became a somewhat frequent visitor to the blossoms of a large thistle-like plant growing along ditch banks.

Family Cypselidæ: *Swifts.*

47. Chætura pelasgica, Baird.—*Chimney Swift.*—Common after March 21st.

Family Caprimulgidæ: *Goatsuckers.*

48. Antrostomus carolinensis, Gould.—*Chuck-wills-widow.* — On and after April 5th, several specimens of both sexes were observed in the drier woodland and thickets immediately bordering the plantations. The stomach of a female shot on April 14th contained the partially digested body, *entire*, of a swamp sparrow, intermingled with the feathers of which were numerous remains of insects, chiefly small beetles. This fact, taken in connection with a similar instance mentioned by Baird, Brewer and Ridgway,* would seem to indicate that small birds form a portion of the regular bill of fare of this species.

Family Picidæ: *Woodpeckers.*

49. Picus pubescens, Linnæus.—*Downy Woodpecker.*—A few specimens only observed.

50. Hylotomus pileatus, Baird.—*Pileated Woodpecker.*—The only specimen seen was a female, taken March 25th; it was silent and very shy.

51. Centurus carolinus, Bp.—*Red-bellied Woodpecker.*—A male, taken March 30th, was the only specimen of this species seen.

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* North American Birds, 1874, vol. ii., p. 403.

52. Melanerpes erythrocephalus, Swainson.—*Red-headed Woodpecker.*—Notwithstanding the large extent of timbered country in this region, there seemed to be a remarkable scarcity of Woodpeckers of all kinds. But two or three individuals of the present species were noted, one of which made his first appearance in the dooryard on April 14th, after which he remained about the immediate neighborhood, amusing himself by beating a "*tatoo*" on the roof several times daily.

53. Colaptes auratus, Swainson.—*Yellow-shafted Flicker.*—The only member of the family observed in numbers. They seemed to much prefer the vicinity of pastures and hedges to the wooded districts.

Family Alcedinidæ : *Kingfishers.*

54. Ceryle alcyon, Boie.—*Belted Kingfisher.*—A few observed at intervals throughout our visit.

Family Psittacidæ : *Parrots.*

55. Conurus carolinensis, Kuhl.—*Carolina Parakeet.*—I am indebted to my young friend Thomas B. Burns, of "Cinclare," for information respecting this species, which was observed by him in September, 1880, in flocks of two or three dozen flying along the Mississippi, and alighting in trees and on the ground. He also states that on one occasion at least they came in such numbers that the negroes turned out with shot-guns and procured many of them for the table. He has not observed them in the spring.

Family Strigidæ : *Owls.*

56. Aluco flammeus americanus, Ridgway.—*American Barn Owl.*—The only specimen of this species observed was a male, taken April 14th, which was flushed in broad daylight from the lower branches of a Gum tree, and took refuge high up in a Cottonwood, where it was shot. Its stomach contained remains of four shrews (*Blarina*) and four mice (*Hesperomys*).

57. Strix nebulosa, Forster.—*Barred Owl.*—Seemingly a rather common species, its peculiar hooting being often heard in the swamps even on clear and bright days. The only specimen handled was a female taken March 30, which did not appear to differ appreciably from Ohio specimens.

58. Bubo virginianus, Bp.—*Great Horned Owl.*—Not observed, but I was assured by residents of its occurrence.

Family Falconidæ: *Falcons.*

59. Tinnunculus sparverius, Vieillot.—*Sparrow Hawk.*—Several observed about cultivated grounds.

60. Elanoides forficatus, Ridgway.—*Swallow-tailed Kite.*—Seen daily after April 1st, usually in pairs skimming over the tree-tops along the borders of woodland. The only sound it was heard to utter was a short sharp cry, evidently a note of alarm.

61. Buteo borealis, Vieillot.—*Red-tailed Hawk.*—Rather common about cultivated grounds and recent clearings.

62. Haliaetus leucocephalus, Savigny.—*Bald Eagle.*—Occasional specimens noted along the Mississippi.

Family Cathartidæ: *American Vultures.*

63. Cathartes aura, Illiger.—*Turkey Buzzard.*—A common species. Breeding March 25, as evidenced by an egg taken on that date by a negro, who carried it home with a view to hatching it under a hen, saying that it would make a "nice pet."

34. Catharista atrata, Less.—*Black Vulture; Carrion Crow.*—Common throughout our visit, hunting chiefly along the river in parties of six or eight. The flight of this species, when hunting for food, is performed in small circles with frequent flappings and sailings alternately, and this, with its whitish-tipped wings and short square tail serves to readily distinguish it from the Turkey Buzzard even at a great distance. On our homeward journey the Black Vulture was frequently observed along the Mississippi and Ohio rivers, the last noted being a party of eight, thirty-five miles below Louisville, Ky., on April 28th.

Family Columbidæ: *Pigeons.*

65. Zenaidura carolinensis, Bp.—*Mourning Dove.*—Common resident.

Family Perdicidæ: *Partridges.*

66. Ortyx virginianus, Bp.—*Bob-white; American Quail.*—One small covey of six or eight individuals were the only Quail observed during our stay.

Family Ardeidæ: *Herons.*

67. Ardea herodias, Linnæus.—*Great Blue Heron.*—Several specimens seen about the swamp.

68. Herodias alba egretta, Ridgway.—*American Egret.*—Scattering specimens observed in the willows, etc., along the Mississippi.

69. Florida cærulea, Bd.—*Little Blue Heron.*—Flock of fifteen or twenty, in both blue and white plummages, seen feeding in an overflowed meadow on April 10th.

70. Butorides virescens, Bp.—*Green Heron.*—A rather rare frequenter of ditches and canals; first observed April 14th.

Family Charadriidæ: *Plover.*

71. Charadrius dominicus, Mull.—*Golden Plover.*—Frequented the pastures and stubble fields from April 2d to 15th, in flocks numbering from a dozen to twenty individuals.

72. Oxyechus vociferus, Reich.—*Killdeer.*—Occasional migrant along the river.

Family Scolopacidæ : *Snipe.*

73. Gallinago media wilsoni, Ridgw.—*Wilson's Snipe.*—On April 1st, in company with our host, Mr. Joseph Collins, we repaired to a favorite snipe ground within a few miles of "Silvery." The place had formerly been an extensive and valuable sugar plantation, but a *crevasse* occurring in the levee opposite, some years previous to our visit, had let in the flood of waters, and converted the level plain into a series of ridges and gulleys, with here and there a small pond ; the whole overgrown with weeds and vines, and forming a very attractive resort for *Gallinago.* Here we enjoyed several hours of good sport, finally turning our horses' heads homeward with full pockets, sharpened appetites, and that peculiar sense of general satisfaction known only, perhaps, to the successful sportsman.

74. Actodromas maculata, Coues.—*Pectoral Sandpiper.*—Common from March 23d to April 10th, in parties of from three to five individuals, frequenting the grassy margins of small ponds.

75. Totanus melanoleucus, Vieillot.—*Greater Yellow Legs; Telltale.*—A few specimens observed about small ponds.

76. Totanus flavipes, Vieillot.—*Lesser Yellow Legs.*—Migrant, April 10th to 15th, in limited numbers.

77. Rhyacophilus solitarius, Cassin.—*Solitary Sandpiper.*—Common in the usual places and numbers from March 30th to April 15th.

78. Bartramia longicauda, Bp.—*Bartram's Sandpiper; Field Plover.*—Frequented the plowed grounds and pastures from April 1st to 12th, singly and in parties of from three to six.

Family Rallidæ: *Rails.*

79. Fulica americana, Gmelin.—*American Coot.*—Observed in small parties along the Mississippi April 19th.

Family Anatidæ: *Swan, Geese and Ducks.*

80. Bernicla canadensis, Boie.—*Canada Goose.*—Flocks of fifteen or twenty observed in the fields near New Madrid, Missouri, April 22d.

81. Fulix affinis, Baird.—*Little Black-head Duck.*—Occasionally seen along the Mississippi during March and April.

Family Laridæ: *Gulls.*

Note: Two species of large Gulls observed about the river at New Orleans and above, were presumably the Herring and Ring-billed, although no specimens were handled of either.

Family Podicipidæ : *Grebes.*

82. Podilymbus podiceps, Lawr.—*Thick-billed Grebe.*—Occasional on the Mississippi.

Family Colymbidæ : *Loons.*

83. Colymbus torquatus, Brünn—*Loon.*—Not noted in Louisiana, but observed quite frequently along the Mississippi after passing Memphis on April 21st. At the approach of a steamboat they will usually dive once or twice, but finely take to their wings with labored flappings and out-stretched necks, leaving a long wake in their rear as they drag their posterior parts along the surface. In no instance were they seen to raise their bodies entirely clear of the water.

ON THE GEOGRAPHICAL DISTRIBUTION OF CERTAIN FRESH-WATER MOLLUSKS OF NORTH AMERICA, AND THE PROBABLE CAUSES OF THEIR VARIATION.

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PART II.

Having set forth, in a previous number of this Journal, the main facts connected with the distribution of the *Unionidæ* and *Strepomatidæ*, over the region under consideration, it now becomes my task to attempt a solution of some of the problems thereby indicated; for to the careful student of this subject, several of its features are in the nature of unanswered questions, and these, it seems to me, will be found to be so intimately associated with the history of our continental development, and especially with that part relating to the evolution of the systems of drainage, as to cause continual reference to that subject, in the light of present geological knowledge.

Without stopping, at this point, to discuss the zoological relationships which possibly indicate the marine ancestry of the mollusks under consideration, it is a fair presumption that *the first fresh water forms were lacustrine.*

Of this proposition there seems to be ample evidence in the fact, that even during Archæan times, fresh water lakes were not impossibilities or even improbabilities. The processes by which salt water areas, isolated from the main ocean, pass through their various stages of approach to fresh water conditions, are familiar to all students of physical geography; nor is the fact of the existence of such bodies of water in regions of limited drainage, any less well known. High plateaus and low plains alike contribute examples of this fact. They are most typical in regions of comparative aridity from various causes; and many such bodies of water now known, have been undergoing the freshening process since the early Tertiaries.

It can not, I think, be doubted that there have been, throughout the geological ages, depressions of this description; and when we consider the fossil shells found in lacustrine deposits, and the forms now inhabiting such bodies of water as Lake Baikal and Lake Bálkash, the probability of their gradual differentiation from marine types, and of their successive variations as fresh water forms, seems to be associated with no factor of the improbable.

In this consideration due weight must be given to the great influence of Archæan lands upon the subsequent moulding and forming of the continent, whose final systems of drainage, and all the stages of development leading to them, were determined by this early and stable region, which had its representative areas on both sides of the incipient uplift, and at comparatively isolated points over the great central basin; areas around which clustered, throughout the history of continental progress, the geological activities that determined everything.

It seems desirable, in discussing the variations above hinted at, to remember that there must have been a far greater impetus given them, when changes in drainage brought to these creatures the vicissitudes accompanying distribution into bodies of flowing water. Such changes of station, and finally of habitat, were among the last possibilities of continental growth, because it was only in connection with the later grand movements associated with terrestrial evolution, that present systems of drainage become possibilities. It is likewise true, that at no time since any drainage became possible to the continent, in streams large enough to contain a shell fauna, has there been such a complication of circumstances favorable to the local variation of that fauna, and the consequent establishment of varieties as now. For while it is a well determined fact in geology, that with the progress of continental evolution, the complexity of the characters of strata increased, it is also true that each of these new features would become a factor of importance in modifying the character of streams flowing through the land, and would, for this reason, aid in changing the nature of the mollusks inhabiting them; and these facts reach their greatest development in mountain regions, for the following among other causes that may be enumerated.

First, it is in mountainous regions that streams cut their way through strata of the most heterogeneous character, partly owing to the effects of metamorphism and other disturbing causes upon strata that may have been, originally, more homogeneous. *Second*, because even where metamorphic effects may be wanting, the range of formations traversed will be greater through the more extensive erosion. *Third*, because in mountainous regions there is an increase of probability that mineral deposits will fall in the path of streams, which will effect changes in the water, causing abnormal stunting, or extraordinary development of given forms. *Fourth*, because the influx of side streams, bearing the water of mineral springs, will add to these effects.

Fifth, because here we have the maximum of extremes in rate of current, and consequently the maximum of capacity to transport sediments that may act favorably or unfavorably upon the various creatures inhabiting these streams. *Sixth*, because of the probability that these mollusks have been propagated down stream, to the limit of favorable conditions—a limit always determined in the first place by geological causes—and because of the variation in the conditions met in this traverse. *Seventh*, because combined with all these causes is the fact, that all the stages in the development of these creatures are passed in an element thus unstable, amid conditions thus diversified, where the slightest tendency to variation must have the maximum of exciting causes constantly operating to call it into play. If, then, it be admitted that there is in the animal races any capacity for adaptation, and any tendency to variation, life, under such circumstances, would be a continuous development and exercise of these inherent qualities. For mountain regions have been the seat of origin of all drainage, and, no doubt, of the first forms of life inhabiting that drainage.

Now let us examine these probabilities in the light of the actual facts connected with the distribution of certain fresh water-shells.

First, we may consider the circumpolar distribution of certain *Limnæidæ.* These mollusks are essentially *lacustrine*, for while they are distributed into rivers and smaller streams to some extent, their station of fullest development is in lakes the world over.

The genera, *Physa*, *Limnæa* and *Planorbis*, are essentially northern forms, for it is in the cooler regions of the earth that they reach their largest size and greatest differentiation. Distribution southward is accompanied by a stunting of forms, in all cases but that of the subgenus *Bulinus*, of which the *B. aurantium* passes through the American tropics, and is many times the size of its circumpolar northern relative, the well-known *B. hypnorum.* This case stands as the only exception to an otherwise universal rule, in a group of mollusks covering in many described species, and yet one in which the differentiation of forms has led to such interminable varieties, that the most critically accurate of our conchologists hesitate to label them. The careful student of our North American forms, will find these shells more closely allied to their European relatives than any other group of mollusks found on the two continents, unless it be the *Succininæ*, and a few littoral marine species; and as it is not possible to separate the species, *inter se*, upon anatomical distinctions, in the greater number

of cases, it may be regarded as a substantial proof of their high antiquity when taken in consideration with the following facts; first, their universal presence in the lakes of the older geological formations at the north; second, their circumpolar distribution; third, their presence in regions unfavorable to the development of other families of mollusks, as testified by their absence ; fourth, their persistent appearance together, even southward, over regions of elevation. For these reasons, and for others of convenience in this discussion, I shall designate them as Fauna A, and will add this important and distinctly proven statement; that they reach, on our continent, their maximum of size, of differentiation, and the greatest local number of so-called species, in precisely that portion of it having the greater number of lakes, in regions of the oldest land or contiguous to it, and where there is the greatest paucity of other mollusks. This fauna is thus clearly shown to be regional, and the inference is fair that it has a very high antiquity.

Over the same region, both in Europe and America, we have distributed a few species of the *Unionidæ,* mostly represented by the genus *Anodonta*, a lacustrine group, always affecting still waters with muddy bottoms. These forms, with plain surface, and comparatively thin shells, are the predominant types of this family over the whole northern portion of our continent, from Maine to Oregon. It is among these mollusks that there occurs the greatest apparent synonymy, and the systematic zoologist will find himself, in the study of these shells, face to face with the question of varieties in endless and interminable confusion. Nor is this statement an exaggeration, when we remember that European malacologists of greater or less repute have made nearly one hundred synonyms for the *A. cygnea* alone; and that the slightest review of our North American species in the light of the evidence offered by geographical varieties, now well known, must reduce the number of so-called species more than one half ; and many of these varieties continue from eastern New York to Minnesota, and a fewer number southward to the very borders of Mexico, *over all of which area I have traced them!* These shells, for like reasons with the first, I shall designate as Fauna B.

The region occupied by A and B contains very few representatives of the *Strepomatidæ,* or Fauna C. Their geographical range northward was set forth in the first of these papers; and it is a significant fact that the few species of the *Strepomatidæ* occupying this region are those belonging to types that, further south, where the

conditions of variation enumerated in another part of this paper reach their maximum, are so intimately united by varieties as to render their separation into distinct species, in most cases, utterly impossible, as the shells from different localities are so completely blended, that it is no exaggeration to say that fifty per cent. of the described species are the merest synonyms. At the north, even, the difficulty begins; and it vastly increases in the mountainous region further south. This fauna differs essentially from A and B, in that it is not, normally, lacustrine, but fluviatile. A very few species are found in lakes, occasionally; but there is in these shells, an inherent aversion to still water, which characterizes all the genera, leading them to seek rather the rapid parts of rocky streams; and here it is that we meet their greatest diversity of types, and the greatest variety of coloration and ornamentation. This peculiarity of station is so persistent, that no skilled collector ever searches for them in level reaches of deep water, unless in the case of a few species of *Pleurocera*, which affect such localities; but *Io*, *Angitrema*, *Lithasia*, *Anculosa*, *Schizostoma*, *Goniobasis*, and *Strephobasis*, all genera represented by an infinity of varietal forms, seek always clean, rapidly flowing water, in rocky or gravelly river beds; and these groups are only represented by the genus *Melanopsis*, over the same range in Europe and Asia, and by *Goniobasis* and *Pleurocera* at the north, in America, their grand metropolis; in foreign lands, their representatives, also, are confined to a range mostly south of that occupied by A and B. This fauna has a very limited distribution of genera and species west of the Mississippi, a fact easily traced, I think, to true geological causes, some of which are past, and others now in operation.

The shells designated as Ohio River Types in my previous article, I shall call Fauna D. Of its geographical distribution, varieties, and persistent forms, enough was said in that paper; and since it was written, I have received, from the very southwestern borders of Texas, a collection of Uniones gathered at random, which contains nothing but absolutely typical Ohio river species. South of the Ohio, in parallel streams, beginning with Kentucky river and Green river, and continuing to the eastern and southeastern tributaries of the Tennessee, we find, as has already been stated, a group of shells of a distinct facies, requiring no expert knowledge of chonchology to enable one to see that it differs, as a whole, from the Fauna D, with which it is associated. Its southern distribution is co-extensive with that of Fauna C, in all the larger and many of the smaller streams. Here occurs the greater

number of described "species" of the genus *Unio;* for among the forms filched from these prolific streams, malacological enthusiasts have disported themselves as species-makers, until the crying need of our times is an honest, impartial, and thorough review of the whole subject. The approximate boundaries of Fauna E may be placed between the Ohio river on the north, the Tennessee on the south, the Appalachians and the Mississippi. One fact is of curious import here; and it deserves to be put upon record in this discussion, and in this place. In his last edition of his Synopsis of the Family Unionidæ, 1870, which he tells us is his "most important work," Mr. Lea makes the following remarkable statement, the truth of which he had abundant opportunities to verify; "although I have examined critically, and published descriptions of the soft parts of 254 species of this family, and have often dissected 50 to 100 of the same species, I can not see, as yet, any useful division that could satisfy the student or the adept, which can be made by systematic difference in the organic forms of the soft parts." This means, I suppose, that the differences of the soft parts are so small as to afford no safe basis upon which to predicate classification. I may add to this, that the most intimate study of the anatomy of different species of the *Limnæidæ* and *Strepomatidæ*, has convinced me beyond resonable doubt, that specific differences, supposed to be indicated in the shells, do not extend to the animals themselves, so far as these studies go to show. I have now in course of preparation a memoir on this subject, which I hope soon to publish with accurate anatomical illustrations. Here is one of those strange facts, standing at the very threshold of the question of evolution, which finds a parallel in the *Lingula* and the *Rhizopod.*

We may now venture upon a few suggestions, to which these facts give rise. Clearly the oldest shell fauna upon the continent would have naturally inhabited Archæan regions ; and as it is altogether likely, from chemical facts associated with the deposit of iron ores, and the presence of graphite in the older rocks of the continent, as pointed out by Prof. Dana and Dr. Hunt, that organic life may have existed to an extent not yet determined by fossils actually discovered as such, I think we do not pass beyond the bounds of probability in assigning to Fauna A a very remote antiquity. From its original *locus*, it has spread to the limit of suitable conditions, a limit undergoing constant variations, perhaps, through the geological ages, but which has been determined by boundaries mainly fixed by true geological causes. Through adaptation this fauna has, in a few cases, overstepped its

primitive barriers, but it remains, as we have seen, true to its original instincts in all its more important phases. It is not probable, as may be suggested by the doubting reader, that this fauna would have been exterminated by the great glacier, which is supposed to have originated in its peculiar haunts, but more likely that the few species having an abnormal southern or southwestern range, received the first impulse of distribution in that direction from the glacial condition; and that with the northward retreat of the glacier they simply resumed their normal habitat, continuing their distribution in that direction in succeeding times to the northern lakes of British America. In case of Fauna B we have evidence that a previous distribution, probably severed, by the same or other causes, has never been fully united in a few cases, as in that of the *M. margaritifera*, occurring in Maine and Oregon, but not between these stations so far as now known. But in most cases, the re-union has been complete. Such remnants as the glacial epoch left, have been equal to the emergency of perpetuating their race over the region desolated by glacial action, and they may thus indicate what are the possibilities of development under determinate conditions. It may be suggested, that as the species of so-called *Strepomatidæ* of the west coast have rather the facies of the tropical Melanians; and as the other associates of the *M. margaritifera* in the waters of Oregon are species not elsewhere found, that this little faunal remnant is an independent one, and I readily agree to all this; yet there is no doubt of the existence of a Fauna B, nor of its distribution, and the possibility that its present species are the descendants of a geological remnant like those of A. Still more striking is the evidence to be adduced from Fauna C. The region over which this group is distributed may have had some drainage, though perhaps slight, as far back as the epoch of the Cincinnati uplift. It thus may have continued through all the Palæozoic ages thereafter. What wonder, then, that we have here such a diversity of forms, when we remember the mutations through which the continent subsequently passed to the termination of the Palæozoic. Local elevations and submergencies, and the various phenomena associated with the progress of continental development, brought to these creatures a series of vicissitudes that may have left many remnants in favored spots, whose descendants, modified and changed as they are, afford us the multitudinous varieties which this fauna assumes throughout its metropolis.

Indeed, if we could reach the ancestral form of these creatures, we should have another proof of the existence of what Prof. Dana so philo-

sophically called "comprehensive types;" and it is by no means a difficult thing to show abundant evidences of their presence in this heterogeneous host of their modified descendants, as I hope to point out hereafter. Even if this fauna does not antedate the Carboniferous epoch, the station which it has always occupied, for reasons already shown, would have brought a maximum of differentiating causes to bear. Nothing seems clearer to me than the separate origin of D and E. This is indicated by the merest superficial study of the shells, and I confidently expect that future geological explorations, among the western Tertiaries, may bring to light additional evidence upon this subject; and that when the habits and anatomy of these animals have been more thoroughly studied, and when we have a fuller understanding of the relations existing between the living and fossil species of western Europe, and the fossil Tertiary species of southeastern Europe, new light will begin to break in upon the "origin of species" among these protean bivalves; for such work is the special province of geology, and the highest generalization to which the perfection of geological knowledge can lead us. In considering the facts connected with the exploration of the western lake basins, we find the *Unionidæ* to be distributed through the whole series of deposits from the Jurassic to the Tertiary, and well through the latter. In a very philosophical discussion of this subject, Dr. White has shown that there is an intermingling of forms, and an extent of differentiation pointing to remoter origin. But he has, in a foot note on page 620, made the following statement that needs correction. "It is a significant fact that those North American rivers which contain the richest Unione fauna drain Mesozoic and Tertiary regions, while those that drain Paleozoic and Azoic regions have a comparatively meagre Unione fauna." The whole drainage of the Ohio is Palæozoic, or so nearly so that we may call it such. This stream and its tributaries south and southeast are the metropolis of these shells. And it is here that we find the two faunas above indicated most distinctly developed. The rivers draining the Mesozoic and Tertiary regions of the west have a very meagre fauna, both as to species and individuals; and I have already stated, that with the exception of the few *Anodontas* of the northwest, the entire assemblage is composed of Ohio types. Until series of casts of the Ohio river shells are made, and these are carefully compared with the casts of species described from these western localities, we shall not have reached the best conclusion which a study of these fossils will afford us. If we consider the species of the Mesozoic and Tertiary regions

of the south and southwest, we shall find that when we have removed the Ohio types from the lists, very few valid species remain. How absolutely true this is, and how great the synonymy of these shells, I am sure is not the well understood fact in American malacology that it ought to be. There can be little doubt that the distinctively Ohio types, these widely distributed, and so greatly differentiated, antedated any other forms occupying the same region with them. But other groups, during the mutations of the geological ages, left their remnants which have spread over the same area. The persistent species have either less tendency to variation, or the precise circumstances to call out such latent energies have not yet been brought into active account; while other forms, for opposite reasons, present us an infinity of varieties, always easily recognized, and of the derivative character of which no person who has investigated this subject can have any doubt.

In this connection the isolated fauna of the Coosa, to which reference was made in the previous article must not be neglected. This stream flows through a comparatively limited drainage. It contains two genera, *Schizostoma* and *Tulotoma*, represented by thirty species, that have not yet been found outside of it; and this in a region where every stream contains an abundance of *Strepomatidæ*. How easy for a slight geological disturbance to obliterate the record of their existence; how easy to have an isolated remnant of this unique fauna left in the upper reaches of this mountain stream, when a less submergence, than took place in this region during the Tertiary, would exterminate many contemporary species in the lower part of its drainage. In such a case, this isolated remnant, unique and strange, would present us with a problem for consideration like that of the *Unio spinosus*. This single example well represents the principle to which this article points, and shows how readily, in earlier times, when systems of drainage were comparatively limited, and opportunities for the spread of species were correspondingly less, there might have been many cases like that of the Coosa, during the various Epochs, which left remnants of their shell-fauna; and those remnants, which had less tendency to variability, have persisted with comparatively little change; or, possibly, the changes have been in a direction which did not characterize other groups with which they were associated, leaving them distinct. At all events, the faunas are plainly indicated, and in many cases it is not difficult to point out central forms, around which they seem to be clustered. The various other genera of Fresh-Water Shells, found in the western deposits above mentioned, all exhibit a tendency to varie-

ties equal to that of the *Unionidæ*. The species of *Goniobasis* (?) *Viviparus*, *Physa*, and *Planorbis*, are all cases in point; but one can not help seeing how closely the three genera last mentioned are related in all these fossil forms to species now living; and it seems that Dr. White's remark, accompanying the description of the *Anodonta propatoris*: "It is not to be denied that its separate specific identity is assumed from its known antiquity, rather than proved by its structure and form," might have been, with still greater significance, written of many of these fossil *Viviparidæ* and *Limnæidæ*. Let this be as it may, I am convinced that the origin of these Tertiary and Cretaceous forms, is to be sought in a Palæozoic progenitor, whose probable starting point was in regions adjacent to the western Archæan. While the species of fresh-water habitat may have persisted since the Carboniferous, in all the region between the Appalachians and the Mississippi, much of that portion of geological time has been fatal to such existence in the region west of the same stream; and though Mr. Tryon speaks of the Mississippi as a barrier to the westward distribution of species, it seems to me that the cause is really to be found in the character of the western tributaries as well; for while the muddy waters of the Mississippi are an effectual barrier, in a general way, accidental transportation or a few cases of actual traverse, that we can not doubt must have taken place, would have furnished abundant materials for spreading the species through our western rivers, if the conditions had been favorable; but they were not favorable, and consequently no such distribution has taken place. Hence it is, that the few species of shells inhabiting those streams, seem to me more likely to be the descendants of ancestry of an old date, and their general correspondence in form to the Ohio type, points to their community of origin. The fauna E is here wanting; nor has it any representative. When we come to the consideration of the down stream distribution of the species east of the Mississippi, we find the *Strepomatidæ*, as represented by their most characteristic genera, and Fauna E of the *Unionidæ*, to have a barrier in that direction. Here they cease, and beyond it, in the Tennessee, Cumberland, etc., we find mainly the Fauna D. Since this fact is general, it becomes one of high significance in this discussion, and stands as a unique evidence in favor of some of the suggestions here made; and it shows, conclusively, that continuous water is not the only condition of molluscan distribution; and that the present station of *Io*, *Goniobasis*, *Anculosa*, etc., in mountain streams, and in the more rapid portions of

these streams, is the result of the presence of conditions to which these creatures are by nature fitted; and while a few species are more cosmopolitan, owing to their greater capacity for adaptation, or to their remote ancestry, the great bulk of Fauna C has its range circumscribed as has here been indicated.

While the evidences upon which the theory of this discussion rests, from the geological and phylogenic aspects of the case, have been thus hurriedly cited, there is yet another argument, resting mainly upon an anatomical basis, which, as above indicated, I hope, after a while to bring out. So little is known of the close relations of these animals from this point of view, that I am of the opinion that the systematic zoologist will look with wonder and surprise upon the almost entire absence of structural likeness in animals, even in such matters as the distribution of the alimentary and circulatory vessels, that may be associated with the widest variation in the character of the shell. Nevertheless, there are cases in both these families, of structural differences as striking as the other facts which have led to this division of our shells into these highly characteristic geological groups; and to these evidences I shall direct attention in a future article.

NEW SPECIES OF FOSSILS AND REMARKS UPON OTHERS FROM THE NIAGARA GROUP OF ILLINOIS.

By S. A. Miller, Esq.

I have recently had the opportunity of examining a very large collection of crinoids belonging to W. C. Egan, Esq., from the quarries at Bridgeport and Cicero, near Chicago, Illinois. It is, probably, the best collection ever made at those quarries, and it has enabled me to re-define and restore several species which, from imperfect specimens, have been classed as synonyms of those described from other places.

The genus *Saccocrinus* was founded upon *S. speciosus*, from the Niagara Group, at Lockport, New York, in 1852, by Prof. Hall. In 1863, he described *S. christyi* from the Niagara Group, at Waldron, Indiana, which is beautifully illustrated in 28th Rep. N. Y. St., Mus. of Nat. Hist., published in 1879. In 1867, in the 20th Rep. he characterized *S. semiradiatus*, from Racine, Wisconsin. In 1875, in Ohio Pal., vol. ii., Hall and Whitfield defined, from the Niagara Group, at Yellow Springs, Ohio, *S. ornatus*, and *S. tennesseensis*. In 1865, Winchell

and Marcy, under the generic name of *Megistocrinus*, published, in the Memoirs of the Boston Society of Natural History, three species that were collected in the Niagara Group, at Bridgeport, viz: *S. infelix*, *S. necis*, and *S. marcouanus*. Prof. Hall, at that time, regarded these species as identical with *S. christyi*, though in the 28th Report, above referred to, he classed as synonyms only *S. infelix* and *S. marcouanus*. I am enabled now not only to distinguish the three species of Winchell and Marcy, but to determine three new species from the same quarries. The inferior specimens studied by these gentlemen, and the poor illustrations furnished by the Boston Society, no doubt led to the many erroneous conclusions that have been formed respecting these Bridgeport crinoids, for there can not be found, in any genus, four species more marked and distinct, from each other, than *S. christyi*, *S. infelix*, *S. necis*, and *S. marcouanus*. Indeed, one might hesitate before referring them all to the same genus, and if *S. marcouanus* were found in rocks of another age, it is more than probable it would be defined as a new genus. But from the great abundance and large size of the crinoids at Bridgeport, we may fairly presume, that they lived in a situation most favorable for their development, and hence, that we may expect to find extreme variations in the forms belonging to the same genus. This great diversity is all the more likely in a genus having such an extended geographical range as *Saccocrinus*. For this reason a new definition of the generic characters may not be inappropriate.

Saccocrinus, Hall, 1852.

Body more or less elongated, urn-shaped, obconoidal, or sack-like in form. Basal plates, three; radials, three by five; secondary radials, from one to four by ten; tertiary radials, in species where they exist, usually, one by twenty; regular interradials, ten to seventeen; intersecondary radials, variable in number; azygous interradials, one, resting upon the basals, succeeded by three, and above this more or less numerous in different species. Arms, ten, twenty or thirty, composed of a double series of plates, and bifurcating after they become free one or more times.

Saccocrinus marcouanus, W. and M.

Plate IV., fig. 1, view of the azygous side of a specimen a little distorted and peculiar, broken off at the constriction below the vault, natural size; fig. 1*a*, view of the vault of another specimen, natural size.

(*Megistocrinus marcouanus*, Winchell and Marcy, 1865, Mem. Bost. Soc. Nat. Hist.)

Body, usually, very large, and sometimes having a length of 4 inches, and diameter of 2½ inches; the specimen showing the vault, and represented by fig. 1*a*, has a length of 2½ inches, greatest diameter, 1 6-10 inches, which is at the top of the first secondary radials, diameter at the constriction below the arm bases, 1 3-10 inches. It gradually expands from a sub-acute base to the first secondary radials, rapidly contracts to the fourth secondary radials, and slightly expands to the top of the vault. This is the normal form, though nearly every specimen is more or less irregular, apparently from pressure, and the base is usually turned to one side.

Basals.—Basal plates, three, equal, hexagonal, and a little wider than high.

Primary radials.—Three of the first radials rest upon the wider sides of the basals, and two in the angles formed at the junction of the basals. Three of them are hexagonal, and two heptagonal, though in one specimen examined, three are heptagonal, the left anterior first radial being heptagonal instead of hexagonal. They are a little higher than wide. In the hexagonal plates, the upper side is the shorter and the lower next in length. The second radials are, usually, hexagonal, nearly as large as the first, always longer than wide, but differing in the proportional length and width in different specimens. The left anterior second radial, in the specimen illustrated by fig. 1, is heptagonal, but this seems to be abnormal, as in all other specimens examined it is hexagonal. The third radials are larger than the second, and usually about the size of the first, though they are sometimes, as shown by fig. 1, larger. The left anterior plate in fig. 1, is octagonal, but the same plate, in the specimen illustrated by fig. 1*a*, has nine sides, four azygous interradials abutting upon it, instead of three. In fifteen specimens examined, I have found four third radials with nine sides, and one with seven.

Secondary radials.—The first secondary radial, in all the specimens examined, is heptagonal, and about two thirds as large as the third radial, with the exception of the octagonal plate in the left antero-lateral series, in the specimen represented by fig. 1. The second plate is smaller and heptagonal, but it does not, as in other instances, in this genus, support tertiary radials. This plate is succeeded by a third and a fourth secondary radial which gradually diminish in size. The fourth plate is followed by two smaller plates, and these again by others belonging to the brachial series. The constriction occurs at the top of the fourth secondary radial, and from this point upward, for about

2-10ths of an inch, there is a slight expansion, and the height is represented by the length of about four interbrachial plates. The arms arise at the point of constriction, but do not become free, until they reach the top of the vault. The double series of brachial plates, which thus form part of the cup, project beyond the interbrachial plates and leave depressed interbrachial areas.

Interradials.—The first regular interradials are hexagonal, a little smaller than the first radials, and succeeded by about 16 plates, arranged, irregularly, into pairs, before reaching the point of constriction; and from this point to the top of the expanded vault, and between the bases of the arms, there are about twenty interbrachials.

Intersecondary radials.—The first intersecondary radial is hexagonal, and a little smaller than the first secondary radial; it is succeeded by three pairs of plates which gradually diminish in size to the point of constriction, and from this point to the top of the vault there are about twenty interbrachials.

Azygous interradials.—The azygous area below the constriction, contains 44 plates, and has the appearance of two regular interradial areas, separated by a single series of plates. The first azygous interradial is heptagonal, rests between the sloping sides of the basals, and is like the heptagonal first radials. From the upper side a series of nine plates, part of which are hexagonal, and the others heptagonal, extend to the constriction. Between the upper sloping sides of the first azygous interradial and the adjacent interradials, on either side there is an hexagonal plate which is succeeded by 16 plates, arranged, irregularly, into pairs, very much as they are in the regular interradial areas.

Vault.—The vault is flat, with the exception of a very small central proboscis, and a slightly elevated ridge, extending from it to the margin and down the middle of the azygous area, as shown by a specimen preserving part of the plates. The cast shows a star-like figure on the outer part of the vault with ten rays, extending to the arm furrows, without bifurcation. The vault is covered with numerous, small, polygonal, plates.

Arms.—There are only ten arms in this species, though there is evidence that the arms bifurcated at the top of the vault.

The formula is as follows:

Basals	3
Radials $3\times5=$	15
Secondary radials $4\times10=$	40
Regular interradials $17\times4=$	68

Intersecondary radials 7×5=	35
Azygous interradials	44
Brachials forming part of the cup 8×10=	80
Interbrachials about 20×10=	200

Total number of plates in the cup about 485, instead of 185 as stated by Winchell and Marcy.

Remarks.—The specimen illustrated in the Mem. of the Bost. Soc. Nat. Hist., belongs to this species, and part of the description of Winchell and Marcy is applicable to it, but they evidently described the vault and upper part of another species as belonging to this one, and also had before them another undescribed form which they referred to it. Their diagram, too, is incorrect above the second secondary radial. They do not, however, loose their specific name, because the species to which they referred can be determined by the illustration, imperfect as it is. Moreover, their mistakes are pardonable, for they were not detected, by either Prof. Hall or Prof. Meek, both of whom studied the subject more or less, nor has any one before ascertained the characters of these peculiar casts, nothwithstanding they have been a fruitful subject of discussion since 1865. It is, therefore, not without some pleasure, that I am able to do justice to the work of Winchell and Marcy, restore the compliment intended for the learned and distinguished French geologist, and solve a difficult question in the determination of a species.

Saccocrinus urniformis, n. sp.

Plate IV., fig. 2, view of the left side of a specimen, natural size; fig. 2*a*, view of the vault of a compressed specimen.

Body large, urn-shaped, sometimes attaining a length of three inches, and a diameter of two and a half inches. The basals are rather small. The first radials are large and nearly as wide as high. The second radials are a little smaller, hexagonal, and higher than wide. The third radials are heptagonal, about the same size as the second, and are also higher than wide. The first secondary radials are heptagonal, and about two thirds as large as the third radials. The second secondary radials are heptagonal, and a little smaller than the first. The tertiary radials are about half the size of the latter, and support the brachials.

Interradials.—Regular interradials about twelve in each space, which are succeeded by a few interbrachials. The first is hexagonal and

as large as the second radials; this is succeeded by about five pairs, before reaching the interbrachial spaces, though there is a third plate intervening, at about the height of the first secondary radials. Intersecondary radials, five. The first is hexagonal, and as large as the second secondary radials. It is succeeded by two pairs of smaller plates.

Azygous interradials.—The azygous area contains thirty-two plates, and has somewhat the appearance of two regular interradial areas, separated by a single series of plates. The first azygous interradial is heptagonal, rests between the sloping sides of the basals, and is like the heptagonal first radials. From the upper side, a series of seven plates extend as high as the arm bases, and are succeeded by smaller plates which cover the elevated rounded ridge which passes up over the convex vault and terminates with a small proboscis at the center. Between the upper sloping sides of the first azygous interradial and the adjacent interradials, on either side, there is an hexagonal plate, which is succeeded by five pairs, very much as in the regular interradial areas, and also containing an intervening plate at about the height of the first secondary radials.

Vault.—The vault is highly convex, with a small central proboscis and an elevated ridge extending down the middle of the azygous area. The elevations indicating the connection of the ambulacral furrows, show five rays, in the central part of the vault, which soon bifurcate, forming ten rays, and these again divide before reaching the margin of the vault, making twenty elevated ridges, which extend down the cup to the arm bases, and represent the ambulacral furrows. The spaces between the ambulacral ridges are concave depressions more deeply excavated as they approach the margin of the vault. There are a few interbrachial plates, but they so graduate upward in these concave depressions, to the plates of the vault, that from our specimens they are not accurately determinable. The vault is covered by numerous polygonal plates, the larger ones occurring in the concave depressions.

Arms.—Arms twenty, and from the evidences they were composed of a double series of plates.

This species is distinguished from *S. marcouanus*, by its short, urn-shaped cup, and by the concave depressions in the vault, as well as by the presence of tertiary radials, twenty arms, and a less number of plates. It is distinguished from *S. christyi*, by its shorter cup, the concave depressions in the vault, the presence of interbrachials, the less number of plates below the brachials, and by various other

peculiarities. The form above the tertiary radials is wholly different from that of any other described species.

Saccocrinus necis, W. and M.

Plate IV., fig. 3, azygous side of a medium sized specimen; fig. 3*a*, view, showing a good vault of a slightly compressed specimen.

(*Megistocrinus necis*, Winchell and Marcy, 1865, Mem. Bost. Soc. Nat. Hist.)

This species is variable in form and size. Of twenty-two specimens examined, the smallest has a length of 1 4-10 inches, and a diameter of 1 15-100 inches, and the largest has a length of 2 4-10 inches, and a diameter of 2 inches.

Body somewhat turbinate in outline; pointed below; expanding to the third radial; abrubtly contracting to the arm bases; tumid in the middle anterior region, and flattened or depressed in the upper anterior part; and sometimes having a slightly pentagonal outline when seen from below.

Basals.—Basals, hexagonal, of moderate size, and forming an acutely pointed cup.

Radials.—First radials large, longer than wide, three hexagonal, two pentagonal, the lower lateral sides being the longer ones. Second radials smaller, hexagonal, and longer than wide. Third radials, heptagonal, longer than wide, and supporting upon the two upper sloping sides the secondary radials. There are two heptagonal secondary radials in each series, the first one of which is about two thirds as large as the third radial, and the second about one third as large. The latter are surmounted by single tertiary radials, from which the brachial series arise.

Interradials.—Regular interradials, twelve. The first is hexagonal, and of about the same size as the second radials. It is succeeded by five pairs and one intervening plate, at the region of the greatest body expansion. Above these there are, apparently, four interbrachial plates.

Intersecondary radials. — The first intersecondary radials are pentagonal or hexagonal, and a little smaller than the second secondary radials. The hexagonal ones are succeeded by two small intersecondary radials, and above these, there are, apparently, four interbrachials. The pentagonal ones are succeeded by a single intersecondary radial, above which there are interbrachials.

Azygous interradials.—There are twenty-five or twenty-six azygous

interradials. The first rests upon the upper sloping sides of the basals, and is like the heptagonal first basals. It supports three plates, and these support four, which are followed by irregularly arranged plates, gradually diminishing in size to the top of the cup.

Vault.—The vault is nearly flat, and slightly, if any, raised above the arm bases. Instead of a convex ridge from the center extending down the middle of the azygous area, as is usual in this genus, we have a flat vault, in the central part, and a concave depression near the margin indicating the anterior or azygous side. The whole vault is covered with numerous polygonal plates, without the presence of a proboscis.

Arms.—There are twenty arms.

Remarks.—The surface of the plates, which are preserved in part on a few specimens, appear to have been smooth. Those having a sub-pentagonal outline, when viewed from below, show an angle in the middle of the radial plates, but are without the elevated ridge, which characterizes these plates in *S. christyi.* The vault, in this species, is wholly different from that in any other, but the general outline is, usually, sufficient to distinguish it even when the form of all the plates is destroyed.

Saccocrinus egani, n. sp.

Plate IV., fig. 4, view of the left side of a specimen with the plates preserved; fig 4*a*, view of the vault with the plates removed.

Body somewhat obconic ; length about 1 3-10 inches ; greatest diameter at the arms about 95-100 inch.

Basals hexagonal, wider than high, and strongly convex in the lower central part, so as to give these plates, as seen from below, a sub-triangular outline.

First radials have length and width about equal ; three are hexagonal, and two heptagonal. Second radials hexagonal, longer than wide, and smaller than the first. Third radials smaller than the second, heptagonal, and about as wide as high. First secondary radials hexagonal, and about half as large as the third radials. Second secondary radials much smaller, hexagonal or heptagonal, and support upon the upper sloping sides the tertiary radials. Tertiary radials very small, and support the brachial series.

Regular interradials nine, the lower one of which is hexagonal and about the size of the second radials. This is followed by four pairs of plates gradually diminishing in size to the top of the tertiary radials.

Intersecondary radials three, the lower one hexagonal and supporting upon the upper sloping sides two small plates.

The azygous area is depressed in the upper anterior region, and the number of plates in it are about twenty, but our specimens are not well preserved on this side, and the count can not, therefore, be regarded as accurate.

The vault is flat, with the exception of a central proboscis, and a depression which extends from it toward the anterior or azygous side, gradually deepening to the margin. It is covered by numerous polygonal plates.

There were twenty arms, as shown by the ridges representing the ambulacral furrows in fig. 4*a*.

There are no ridges upon the radials, or that cross from one plate to another, but, on the contrary, all the plates are highly convex and smooth, which, alone, is sufficient to distinguish this species from all others that have been defined. It is not constricted below the arms, and has fewer interradials than most species. It may also be distinguished generally by the obconoidal shape.

The type specimens were collected at Cicero, Illinois, by W. C. Egan, Esq., in whose honor I take great pleasure in proposing the specific name.

CYATHOCRINUS CORA, Hall.

This species, originally described from Racine, Wis., where the arms have not been preserved, occurs at Cicero, near Chicago, Ill. A specimen now before me shows part of the arms. The arms bifurcate and spread almost at right angles on the second plate; they again bifurcate on the second plate, one division ascending straight up; the lower division bifurcates in like manner twice, and the first ascending ray also bifurcates on the second plate. We have here ten rays to each arm, or fifty rays soon after the commencement of the arms. Beyond this point the arms are not preserved.

MELOCRINUS OBPYRAMIDALIS, W. and M.

(*Actinocrinus obpyramidalis*, Winchell and Marcy, 1865, Mem. Bost. Soc Nat. Hist.)

The specimens collected by Mr. Egan show some characters that have not been defined. The body in the lower part is pentangularly obpyramidal. The radial series stand out in salient angles, with de-

pressions between, deepening upward, and giving great prominence to the arm bases.

Basal plates four, about as wide as high. First radials a little longer than wide, and a little larger than any other plates ; three of them are heptagonal the other two hexagonal. Second radials a little smaller than the first, a little longer than wide, and hexagonal. The third radial is a little smaller than the second, heptagonal, and supports upon its upper sloping sides the secondary radials. There are two plates in each secondary radial series, above which the brachial plates arise. The regular interradial series consists of one hexagonal plate, resting upon the first, and between the second radials, and of about the same size as the second radials ; this is succeeded by two hexagonal plates of nearly the same size; and these by a range of three smaller ones, which are succeeded by two plates, and these are followed by the smaller plates of the summit. There is a single plate in each intersecondary radial area. The plates of the azygous area are not determined. The summit is nearly flat, covered with small plates, and possessed of a subcentral proboscis.

Ichthyocrinus corbis, W. and M.

Plate IV., fig. 5, view of a specimen with the plates preserved.

(*Ichthyocrinus corbis*, Winchell and Marcy, 1865, Mem. Bost. Soc. Nat. Hist.)

Winchell and Marcy described this species from the Bridgeport casts, and made its distinctive features consist of a small column, large basals, corresponding to the sides instead of the angles of the pentagonal base, the presence of two instead of three radials, and the perfectly straight transverse sutures separating the plates of the several radial series, except the suture separating two successive series. They were very clearly mistaken in supposing there were only two instead of three radials, and their diagram is therefore erroneous.

Prof. Hall pronounced the species identical with *I. subangularis*, and he illustrated a specimen preserving part of the plates, from Bridgeport, which evidently belongs to the latter species. This seemed to convince palæontologists that *I. corbis* is a synonym for *I. subangularis*. But I have a specimen preserving part of the plates, from Bridgeport, which is quite distinct from the latter species, and as I have no doubt that a large part of the casts, from that locality, belong to the same species, and that many of them were in the hands of Winchell and

Marcy, I propose to restore their name. It is better to use the name *I. corbis* than to propose a new name, especially when it is evident that some of the characters which they saw belong to it, and do not belong to *I. subangularis.*

The body is pyriform, and in our specimen preserving the plates, it is straight, as it is in many of the casts. Other casts have the lower end turned to one side, and have one side more ventricose than the other.

The subradials are pentagonal, and about twice as wide as high. The surface of each is a triangular pyramid, having the apex in the middle of the lower part, one side sloping toward each of the adjoining radials, and the other below. These plates, therefore, when viewed from below, show a pentagon with the angles projecting so that a perpendicular line would strike the sutures separating the second radials in the primary series. There are three primary radials in each series except the anterior one which has four. Three of the first radials are pentagonal, and two hexagonal ; three of the second quadrangular, and two pentagonal ; and three of the third pentagonal, and two hexagonal ; the increased number of sides being caused by each of the plates on the sides of the anterior series abutting against two instead of one plate. The plates have an angular ridge in the middle, which is extended like a node, upward, from the central part of the last radial in each series. The secondary radials have four in each series which are convex in the middle part, but a transverse section here would be nearly round, instead of pentagonal, as it would be, through the primary radials, by reason of the angular extension of the plates.

When the plates are preserved, there is no difficulty in distinguishing this species from *I. subangularis*, by the form of the subradials and primary series, but as we do not know the appearance of the cast of an *I. subangularis*, it is not so easy to show how it differs from the cast of *I. corbis*, which is common at Bridgeport.

The consideration of the Bridgeport and Cicero crinoids will be resumed in the next number of the Journal.

Xenocrinus penicillus, S. A. Miller.

Plate IV., fig. 6, view of the azygous side, showing fourteen plates of the vertical series. The same specimen referred to on page 73 as belonging to Dr. D. T. D. Dyche.

DESCRIPTIONS OF NEW FOSSILS FROM THE LOWER SILURIAN AND SUB-CARBONIFEROUS ROCKS OF KENTUCKY.

By A. G. Wetherby, A.M.,

Prof. Geology and Zoology, University of Cincinnati.

Amygdalocystites, Billings. Can. Jour. vol. ii., 1854.

Amygdalocystites huntingtonii, nov. sp.

Ovate, somewhat wider at the apical end, gradually narrowing below. Length 36, breadth 28 mm. The body is composed of hexagonal and octagonal plates, arranged without regular order. The octagonal plates are larger than the others, but have no order of position. In sculpture and ornamentation they are identical with the smaller ones. The anal (?) aperture is situated very near the center of the apex, at the dorsal side of the shorter arm. It is closed by a series of valvular plates, as shown in figure 3, Pl. V. The arms are so arranged as to form a continuous ridge, the longer one beginning at the ambulacral orifice, at the right outer curve of the apical extremity, and extending down their side quite to the column, and consisting of twenty plates. The shorter, consisting of seventeen (?) plates, extends over the apex, to a point on the side opposite the lower margin of the ambulacral aperture. The plates of the shorter arm near this orifice, and forming the summit of the specimen, are much larger than the others. The plates of the longer arm are nearly equal in size. The pinnulæ are absent in the specimen. The ambulacral groove faces the anal (?) opening in the longer arm, and is placed upon the opposite side of the shorter. The column is round. This species differs from the *A. florealis* of Billings, the only described species with which any comparison is necessary, both in the sculpturing of the plates, and in the length of the arms, as well as in the general form.

The specific name is given in honor of my friend, Geo. S. Huntington, Esq., Civil Engineer of the C. H. & D. R. R., who discovered it in the Trenton rocks of Mercer county, Kentucky, at High Bridge, and to whose cabinet the type belongs.

Cystidean. New Genus and Species.

I herewith figure, Plate V., figs. 2 and 2*a*, a remarkable Cystidean, for which, at present, I give no name, either specific or generic, as I

am unable to refer it to any genus yet described, and hesitate to found a new one upon a single example. The specimen is accurately represented in the figures which show the arrangement of the plates very perfectly on the dorsal side, while, owing to a silicious coating, the basal portion of the opposite side can not be deciphered. The figures are drawn of the exact size. The column is round, and tapers rapidly. The peculiar character of this anomalous fossil is the presence of a single arm, originating between two large plates which form the apex of the body on that side. Seven plates of the arm are shown. Near it, upon the left side, as shown in the figure, is a small tubercle, evidently formed by valvular plates now silicified so as to obscure their arrangement. I figure this specimen in order to bring it to the notice of those interested in the remarkable series of Echinoderms which the Trenton rocks of Canada, and their equivalents in Kentucky, have afforded. I especially invite correspondence from all workers upon these fossils, and should be glad to borrow, and will freely loan any specimens offering instructive points.

AGARICOCRINUS, Troost. Cat. Proc. Am. Ass., 1850.

AGARICOCRINUS CRASSUS, nov. sp.

Formula as usual in this genus. The type specimen is represented in three views on Plate V. Fig. 1, basal view ; fig. 1*a*, azygous side ; fig. 1*b*, summit view, the latter somewhat distorted by the irregular manner in which the specimen is drawn. This species is characterized by the very heavy character of its whole structure, the great thickness of the plates both of the radial and interradial series, and by the massive character of the apical dome plates. The aperture of the azygous side is surrounded, as may be seen in fig. 1*a*, by a ring of regularly arranged pentagonal plates. Beyond these, the arrangement of the plates of this area follow no regular order, nor do they agree in number in different specimens. The smaller plates of the apical series follow the same plan, having no regular order of arrangement, nor being of the same number in the different specimens of the species. A striking character is the arrangement of the pelvic plates in such a way as to render the lower surface of the species slightly convex instead of deeply concave as is usual in this genus. From rocks of the Keokuk group, sub-carboniferous, Tenn. The rocks from which these fossils were obtained, present a vertical section of from 200 to 600 feet. Fossils of the Burlington Group, or those closely allied, occur in the lower part at its greatest thickness.

AGARICOCRINUS ELEGANS, nov. sp.

Formula as usual in the genus.

The type specimen is represented on Plate V. Fig. 4, azygous side ; 4*a*, apical ; 4*b*, basal view. This beautiful species is represented by specimens in a very perfect state of preservation, of which the type is a fair example. The base is concave ; the dome is depressed convex. The plates of the radial series, and of the interradial series below the dome are regularly arranged. The large central apical dome plate is surrounded by six somewhat smaller plates, and two small ones on the azygous side. The opening on this side is surrounded by one row of regularly arranged pentagonal plates ; beyond these the arrangement is without regular order. The subdivision of some of the larger plates in the radial series of the dome affords an interesting caution as to the founding of species, in this genus, upon the number and arrangement of the plates in this portion of the fossil, as may be learned from fig. 4. The fragment of the column remaining, and which is shown in fig. 4*b*, is round, and consists of equal, thin plates. Locality and formation same as the last. Extensive series of many species of this genus show that here the principle of differentiation into varieties seems to have reached its maximum. In many species the basal portion is deeply concave, forming a cup-shaped depression ; in others this depression widens and shallows, and in the *A. crassus* the base is even slightly convex. These variations of the pelvic portion are connected with equally remarkable ones in the amount of elevation of the dome, and the arrangement of the interradial series of dome plates. Equally remarkable are the species in regard to the varying thickness of the plates, some of the species, even when of small size, being composed of very heavy plates; while others are light and thin, reminding one of certain cystideans. I collected several hundred specimens of different species of Crinoids at the locality furnishing these types, and have since learned of the extension of this same bed of Echinoderma far to the south, where the specimens are equally abundant.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The 30th meeting of the American Association for the Advancement of Science will be held at Cincinnati, commencing Wednesday, August 17, 1881.

The officers of the meeting are as follows:

President—G. J. Brush, New Haven, Conn.

Vice-President, Section A—A. M. Mayer, Hoboken, N. J.

Vice-President, Section B—Dr. Engelmann, has resigned as he is in Europe.

Chairman of Subsection of Chemistry—W. R. Nichols, Boston, Mass.

Chairman of Subsection of Microscopy—A.B. Hervey, Taunton, Mass.

Chairman of Subsection of Anthropology—Garrick Mallery, Washington, D. C.

Chairman of Subsection of Entomology—John G. Morris, of Baltimore, Md.

Permanent Secretary—F. W. Putnam, Cambridge, Mass.

General Secretary—C. V. Riley, Washington, D. C.

Secretary of Section A—John Trowbridge, Cambridge, Mass.

Secretary of Section B—William Saunders, London, Ontario.

Secretary of Subsection of Chemistry—H. W. Wiley, Lafayette, Ind.

Secretary of Subsection of Microscopy—S. P. Sharples, Boston, Mass.

Secretary of Subsection of Anthropology—J. G. Henderson, Winchester, Ill.

Secretary of Subsection of Entomology—B. P. Mann, Cambridge, Mass.

Treasurer—William S. Vaux, Philadelphia, Pa.

The officers of the Local Committee are, Hon. A. T. Goshorn, Chairman; Mr. Julius Dexter, Treasurer; and Profs. F. W. Clarke and Ormond Stone, Secretaries.

Committee on Reception, Hon. J. D. Cox, Chairman; Miss E. O. Abbot, Mrs. Robt. Brown, Jr., Mrs. William Dodd, Mrs. T. J. Emery, Miss Fannie Field, Mrs. Richard Folsom, Mrs. M. F. Force, Mrs. G. R. Fries, Miss Emma Goepper, Mrs. Z. M. Humphrey, Mrs. John Kebler, Miss Annie Laws, Mrs. T. D. Lincoln, Mrs. M. L. Nichols, Mrs. A. F. Perry, Mrs. R. S. Rust, Mrs. H. C. Whitman, and Mrs. A. E. Wilde, assisted by 131 gentlemen.

Committee of twelve on Finance, Julius Dexter, Chairman.

Committee of twelve on Rooms, William McAlpin, Chairman.

Committee of nine on Hotels, Herbert Jenney, Chairman.

Committee on Entertainments and Excursions, George W. Jones, Chairman, Mrs. John Davis, Mrs. W. B. Davis, Mrs. Wm. H. Davis, Mrs. A. J. Howe, Mrs. John Kilgour, Mrs. Alphonso Taft, and Mrs. Elkanah Williams, assisted by 18 gentlemen.

Committee of eight on Transportation, W. L. O'Brien, Chairman.

Committee of thirteen on Press and Printing, Archer Brown, Chairman.

THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. IV. CINCINNATI, OCTOBER, 1881. No. 3.

PROCEEDINGS OF THE SOCIETY.

TUESDAY EVENING, *July* 2, 1881.

Dr. R. M. Byrnes, President, in the chair. Present, 18 members.

S. A. Miller, read part of a paper, entitled "Observations on the Unification of Geological Nomenclature, with special reference to the Silurian formation of North America," which he had prepared to be read before the International Geological Congress, which assembled, in September, at Bologna, Italy.

Donations were announced as follows :

From Messrs. Ellison, four species of bird-skins, and two specimens of bryozoans ; from Robert Clarke, 60 species marine algæ—named ; from G. Holterhoff, jr., forty-one species of native birds' eggs, and ninety species of land shells ; from Davis L. James, nine species of seeds ; from Dr. Bronson, one bottle of ashes from a mound in West Virginia, and a viviparous fish from California ; from J. F. James, a tree-frog, and the skull of a crow ; from Kittredge & Co., the U. S. Business Directory for 1878 ; from J. H. & B. M. Seaman, a section of wooden water-main from the streets of Cincinnati—supposed date 1815 ; from Captain A. H. Bugher, through Dr. A. E. Heighway, a magnificent starfish from Florida ; from Dr. A. E. Heighway, a fine specimen of *Peterygotus bilobus*, from Buffalo, N. Y. ; from W. C. Egan, Chicago, Ill., *Saccocrinus marcouanus*, *S. necis*, *S. infelix*, *Melocrinus obpyra-*

midalis, *Ichthyocrinus corbis*, of Winchell and Marcy, recently re-described by S. A. Miller; from James R. Challen, fine specimens of gold-bearing quartz, from Georgia; from Professor J. W. Hall, jr., a specimen of *Cutænia syrtalis*, in alcohol.

By exchange, casts of the horns of two extinct bovine animals, viz: *Bos primigenius*, and *Ovibos cavifrons*, the former from Arkansas, the latter from Italy.

TUESDAY EVENING, *August* 2, 1881.

Dr. R. M. Byrnes, President, in the chair. Present, 15 members.

Mr. Joseph F. James read a paper upon the "Century Plant," and Prof. G. W. Harper made some remarks upon land shells and his new species *Patula bryanti*.

James W. Abert, of Newport, Kentucky, was elected to membership.

Donations were announced as follows:

From B. Kittredge & Co., four volumes of books; from Dr. W. H. Mussey, a curious quartz crystal, from Arkansas; from Dr. J. A. Warder, a pamphlet; from the Smithsonian Institution, "The Proceedings of the U. S. National Museum for 1880;" from U. P. James, Esq., 65 species of Cincinnati fossils, described by himself; from Joseph Foster, jr., 6 specimens of polished marble; from D. M. Stewart, Esq., 9 specimens of steatite; from E. Mills, Esq., 160 species of lepidoptera; and from Prof. G. W. Harper 5 arrow-heads, from North Carolina.

TUESDAY EVENING, *September* 2, 1881.

This evening only seven members including the President were present, and this number being less than a quorum, no business was transacted. The excessive heat, and the fact that the members had attended so many scientific meetings of the A., A. A. S. within the past month, acted, no doubt, to prevent a quorum at this meeting. It is noted, however, as the first meeting within the past five years that failed for want of a quorum.

MESOZOIC AND CÆNOZOIC GEOLOGY CONTINUED—THE DRIFT OF THE CENTRAL PART OF THE CONTINENT.

By S. A. Miller, Esq.

[*Continued from Vol. iv., page 144.*]

We now come to the consideration of the sand, gravel and bowlders constituting the drift of the central part of the continent; the scratches and furrows upon the rocks; the ancient soil beneath the drift ; and the animal and vegetable remains which immediately preceded the drift, and also such as are found within it.

It is idle to talk of continental elevations or depressions, for the whole science of geology and palæontology teaches us of the gradual growth or formation of continents. The appearance of islands above water, until an archipelago is formed, followed by the slow filling up of the shallow places and the intermittent local elevation of mountain chains, through vast geological ages, until the islands are thoroughly united into one vast body or continent, is the history of all continental elevations, and science teaches us of none other, and if continents have been depressed they must now be beneath the ocean, for we know nothing of such phenomena.

We have already seen the vast deposits of the Triassic and Jurassic periods, followed by the marine and brackish water deposits of the Cretaceous age that so well nigh formed the outlines of this continent. The elevation of the mountain chains that caused the formation of vast internal lakes, which have slowly drained themselves through all Tertiary time, and the slight elevation of some parts of the coast during the same period has given us the present form of our continent.

As soon as an island appeared above the ocean the denudation of its surface, from atmospheric causes, began. The rains at once commenced the excavation of valleys and ravines, and when the islands began to assume a continental shape, the valleys must necessarily have been correspondingly increased in size. As the Appalachian range dates back, in part, as far as the close of palæozoic time, so the Ohio river and other streams from this mountain chain have the same age. Another drainage system existed from the Laurentian mountains by a way that has been interrupted and thrown into a series of lakes, but the ancient valley has been traced from Lake Huron through Lakes Erie and Ontario. To the west and north of

this drainage system, vast internal lakes were formed by the elevation of the western mountain chains, which overflowed and drained themselves across the central part of the continent, and produced, as we will see, in the sequel, all the phenomena of the drift.

As heretofore, we will follow the historical and chronological order of discovery as far as practicable.

In 1817, Dr. Daniel Drake,* of Cincinnati, wrote an essay upon the alluvial and drift formations of Ohio and the surrounding country. The letter was not published, however, until 1825. He supposed that the gravel and sand which spreads itself over the western part of Ohio, and is not found over eastern Kentucky, is the result of an inundation, having its origin north of the lakes, and that the large bowlders and blocks of stone, distributed over the country, were transported by large fields of ice and icebergs, which floated from the arctic regions during this inundation. He said, the ice to which they were attached could not of course pass a certain latitude ; and from the great increase of these masses as we advance toward the north, it would seem that many of the icebergs suffered dissolution long before they arrived at this locality.

In 1820, Caleb Atwater† stated, that an arrow-head was found in the alluvium, when digging a well at Cincinnati, 90 feet below the surface ; that a human skeleton was found in the alluvium at Pickaway plains, 17½ feet below the surface, that could not have been interred by human hands in that position ; and he figured and described a human skull of a very low grade, which was found nine feet below the surface, in such a position as to suggest its contemporaneity with the drift era.

In 1825, Sayers Gazley‡ found fossil wood in Hamilton county, Ohio, below the gravel, and intermixed with it and bluish earth, at depths from 10 to 40 feet below the surface, and apparently where the trees had originally grown.

In 1838, Prof. James Hall§ observed the indications of diluvial action, in western New York, in the accumulations of gravel, sand, pebbles and bowlders of all dimensions strewn over the surface. In some places slight scratches were observed on the rocks, while in others they were numerous and deep, often extending for several feet, and in

* Trans. Am. Phil. Soc., vol. ii.
† Am. Jour. Sci. and Arts.
‡ Ibid.
§ Geo. Rep. N. Y.

one case a continuous furrow was found 100 feet in length. The general direction of these scratches is N.N.E. and S.S.W. though they vary a little. One of the remarkable features of the country is a "Lake ridge" passing through the four lake counties nearly parallel to the lake shore, and from four to eight miles distant from the lake. The width of the ridge at the base is from four to eight rods, and narrowing toward the top to only two or three rods in width. In many places it much exceeds this width. The elevation of this ridge above lake Ontario is from 160 to 200 feet, though it varies a little from this at some places. The whole of the ridge is superficial, being composed of sand, gravel and pebbles, in all respects similar to those forming the beaches along the present lake shore. South of the ridge there are numerous parallel ridges, composed of sand and gravel, rising about 25 to 35 feet above the general level, and having uniformly a north and south direction, but never crossing the lake ridge. The opinion expressed in relation to this ridge is that it once constituted part of the shore of the lake, and consequently that the water in the lake was once 160 or 200 feet higher than at present, and that the north and south ridges resulted from the overflow of the lake and the pouring out of its waters in a southerly direction.

Prof. J. W. Foster* separated the surface deposits of Central Ohio into: 1. Vegetable mold; 2. Loam, or a mixture of sand and clay; 3. Sand and pebbles; 4. Yellow clay; 5. Dark blue clay effervescing with acids. The whole of which has a thickness of from 50 to 150 feet. And also over the surface of the country there are scattered bowlders of granite, syenite, quartz, etc. In the region about Columbus, some of these erratic blocks contain 1,000 cubic feet. Not even a primitive pebble has been found on the highlands east of Zanesville, showing that the valley of the Muskingum formed a connection of the currents of water, that swept over the country, with the Ohio river. He described from an excavation for the canal at Nashport, Ohio, *Castoroides ohioensis.* It was taken from a layer of dark carbonaceous silt, below a yellowish clay bed 14 feet in thickness, but above a layer of pebbles of primitive rocks and the blue clay at the bottom of the canal.

Prof. John Locke found the surface of the rocks at Light's quarry seven miles above Dayton, about 448 feet above the Ohio river at Cincinnati, planed, scratched and grooved. The quarry had been stripped of soil, more or less, over ten acres. The natural surface of the stone is very rough, and in some places this roughness was un-

* Ohio Geo. Rep. 1838.

touched, in others the prominences were just touched by the grinding operation, partially worn down, or entirely obliterated, leaving a flat, but unpolished surface, and in many other places the surface is polished, and grooved. The grooves are, in width, from lines scarcely visible, to those three fourths of an inch wide, and from one fortieth to one eighth of an inch deep, and traverse the quarry from between N. 19° to N. 33° west, to the opposite points, in lines exactly straight, and in fassicles of sometimes 10 in number, exactly parallel, cleanly engraved in compact limestone, without seam or fault of any kind, and in a surface ground down to a perfect plane. The grooves appear as if they had been formed by icebergs floating over the terrace, which is the highest in the neighborhood, and dragging gravel and bowlders frozen into its lower surface, over the plane of the stone.

In 1842, Lardner Vanuxem* found the drift scratches in Central New York confined to no particular rock, and at no particular elevation, but not uncommon, and corresponding, in direction, with the course of the valley, or of the valleys in which they occur. One of the best localities for observing the phenomena is at a quarry two and a half miles northeast of Amsterdam. The surface of the rock is covered with soil and earth, which, when removed, shows a water-worn surface with two or three sets of scratches, exhibiting great regularity, and having a common direction toward the east, one set of which is about eight degrees south. The scratches, including furrows, are generally from a mere line to one fourth of an inch wide, and from one to two tenths of an inch and more in depth. Some of them show that the moving power which produced them, passed over the surface with a vibratory or tremulous motion.

In 1843, Prof. James Hall† said that the northern part of the fourth district of New York, and the low slopes and deeper valleys of the southern part, are covered to a greater or less depth by superficial materials of more northern origin, mingled with those of the rock on which the deposit rests. All the formations have suffered greatly from denudation, and the abraded fragments of each constitute a large proportion of the superficial detritus resting on its southern neighbor. The size of the fragments always bears a proportion to the distance they have been transported from the parent rock. Often, a huge mass of a northern rock rests upon the margin of the one next south of it, while at a distance of 10 or 20 miles farther south, only small

* Geo. 3d Dist., N. Y.
† Geo. Sur. 4th Dist., N. Y.

pebbles of the same occur. In some places the coarser and finer materials are intermingled, in the greatest confusion, and heaped up into conical hills thickly scattered over the surface. And again the same materials are accumulated in long hills or ridges having a determinate direction, and sloping down from a high northern elevation to the general level of the country south.

On one hand, we have comparatively an evenly distributed deposit, as if made by the retiring waters of an ocean; on the other, the long hills, with certain directions, show a determinate course and more powerful current in the ocean, while the irregular, conical and dome-shaped hills, with deep, bowl-shaped cavities, show the force of contending currents, or of other obstructions, in the course of the transported materials.

The great bulk of the deposit, whether evenly distributed or irregularly raised into hills and ridges, is composed of the rock but a short distance on the north, or perhaps of the one on which it rests, with a constantly decreasing proportion of rocks of northern origin. The materials of the primary rocks constitute but a comparatively small proportion of the superficial accumulations of western New York. The local origin of the drift is shown by the sections everywhere examined. A section on Irondequoit bay, is as follows: 1. Medina sandstone, shaly with bands of green. 2. Fragments and rolled masses of the sandstone below, with gravel and sand; this contains a few pebbles of the shaly, calcareous sandstone next on the north. 3. Bed of fine sand. 4. Stratum of sandstone pebbles, cemented into a conglomerate by oxide of iron and carbonate of lime. 5. Stratum of pebbles and sand. 6. A course deposit of pebbles of the Medina sandstone below, with gravel and sand. 7. The soil of sandy loam. Another section 70 miles farther west on the bank of lake Ontario, at the town of Wilson, in Niagara county, is as follows: 1. Red clay and gravel of the Medina sandstone. 2. Blue clay and gravel. The pebbles are principally of the rocks of the Hudson River Group. 3. Gravel, clay and sand, of the neighboring rocks, folding over and passing beneath No. 2. 4. The soil of clayey loam with clay below. The sections of the drift almost universally correspond with these, and their explanation, viz: a bed of broken fragments, with worn pebbles resting upon the rock from which they are derived. The granite and other materials of a far northern origin rarely constituting a part. And where they do form a part, the deposit may have undergone some subsequent change.

Grooves or striæ are found upon the surface of all the rocks beneath the drift in the fourth district, which are of sufficient hardness to receive and retain such impressions. From the Medina sandstone, at the level of lake Ontario, to the summit of the Carboniferous conglomerate, in the southern part of the State, some of the strata in every group bear upon their surface these markings of former abrasion, and evidence of moving force. The direction of these striæ vary but few degrees from N. 35° E. and S. 35° W. in their general course. Short and shallow striæ are abundant, which vary ten and fifteen degrees from this direction, but these have no continuous course, and apparently fall into the main direction after a few feet. These markings range from the slightest possible scratch, to grooves of half an inch in width and one fourth of an inch in depth. The grooves seem to have been made by a hard substance, moved with great force and under great pressure, for fragments are found broken out as the grooves approach a fissure in the strata, as if crushed out by some heavy body, and sometimes the grooves are observed following, somewhat obliquely, the fractured slope. The outcropping edges of strata, previously polished and grooved, are often found overturned, upon the rock, in place.

At Rochester, the surface of the limestone is finely striated, and almost perfectly polished by the abrading force. The material here resting upon the rock is fine sandy loam; in another locality a mile farther south, it is covered by coarse limestone gravel and sandstone pebbles, with bowlders of granite. The striæ here are N.N.E. and S.S.W. At Black Rock, the surface of the Corniferous limestone shows that the nodules of hornstone interrupted the progress of the striæ and stand above the surrounding polished surface. The direction here is N. 15° E. and S. 35° W. At the cliff of Lake Erie in Portland, Chautauqua county, the rocky strata below have been uplifted, broken and contorted; the fragments intermingled with clay and gravel, and the same pressed beneath the strata, which otherwise appear to be in place.

The terrace at Lewiston is formed by the upper part of the Medina sandstone, the Clinton Group and the Niagara shale, capped by about twenty feet of Niagara limestone. The top of this terrace is 350 feet above Lake Ontario, and more than 200 feet above the plain about Lewiston. The Niagara shale is carried away so as to leave the limestone of the Clinton Group forming a projecting shelf about 100 feet below the top of the terrace. The surface of this projecting shelf is deeply grooved and striated, the grooves having a general southern tendency, but more irregular than where they are seen upon the lime-

stone on the top of the terrace; and at this place, the surfaces 200 feet lower, and 100 feet higher, are scored in like manner. What agency could produce this effect ? Here is an abrupt elevation of 100 feet above the striated surface; and it seems hardly possible that an island of ice, loaded with granite bowlders, could have stranded upon this projecting shelf, and produced the scoring, and that, at the same time, others above and below could be made in like manner.

The fourth district, in its greatest elevation of about 2,000 feet above tide water, descends to the level of Lake Ontario, 240 feet above tide, for the most part, in a series of steps or terraces over the successive formations; the surfaces of these, from the highest to the lowest, are grooved and striated, and in the limestones often beautifully polished. There is no high land on the north, from which glaciers could originate to cover this entire surface. The relative levels, as well as the directions of the water courses, must also have been different, to have allowed of such effects from glaciers; for, under present circumstances, we should hardly expect to find a glacier advancing from the valley of Lake Ontario, toward the southern margin of the State, and ascending nearly 2,000 feet in 100 miles. Even admitting the glacial theory to be true, it is probable that the glaciers would originate among the mountains of Canada, or farther north among the primary rocks; and in this event, we might expect to meet, intermingled with the earliest drift, a considerable proportion of granite and other pebbles and bowlders of the older rocks, which is not the case.

There is another fact worthy of notice. The vertical faces of joints, when much separated and nearly coinciding with the direction of these grooves, are polished in the same manner as the surfaces. The chinks and fissures, in the harder rocks along the sea shore, are polished, in like manner, by the washing in of sand and pebbles by the advancing and retiring waves.

The first plateau above Lake Ontario is often plentifully covered with bowlders. These usually lie upon the surface, and always upon the top of the drift. They are not evenly distributed, but often appear in immense numbers, scattered over several acres; while beyond this, for a great distance, few are to be found. There appears to be no law regulating their distribution, though they are more abundant in the eastern than in the western part of the district. The bowlders are often in immense numbers on the low ground just north of the Ridge road from Wayne county to the Niagara river, and appear as if they had been brought there while the water was limited by this barrier,

and spread over the bottom in shallow water near the shore. In higher situations, and just beneath the great limestone terrace they again appear in abundance, as if this elevation prevented their farther advance to the south. The bowlders are most abundant in Wayne and the eastern part of Monroe county; going westward from the Genesee they are less so, becoming extremely rare in Erie and Niagara counties. As we ascend the second limestone terrace formed by the Helderberg range of limestones extending westward, bowlders become perceptibly less numerous; they are irregularly scattered, and at few points present the thickly covered fields which are observed farther north. Very few ascend the slope formed by the passage of the Hamilton Group to the rocks above; and in all the previous cases, they seem to have been brought on, at intervals, in great numbers, and their limits bounded by the different elevations of the surface. As we pass southward over the higher groups, bowlders become exceedingly rare; and finally toward the southern margin of the State they are rarely seen.

Some of them bear evidence of much wearing, being actually striated upon the surface, and sometimes flattened on one side, as if held in that position while moved over a bottom of gravel or sand resting upon the strata beneath. For the most part, however, they bear no evidence of attrition beyond what similar masses do a few miles from their parent rock, and thus offer no argument for their mode of transportation. Many of them are angular, and with no appearance of attrition beyond what the weathering in their present situations would produce. The process by which fragments of granite become rounded bowlders, is illustrated by the desquamation which takes place in some granites, the weathering in place, and the attrition in mountain streams soon after leaving their native beds. A large proportion of the bowlders of western New York are of dark felspathic granite and red granites like those of the northern part of the State. Some other varieties occur, which are likewise referable to the same region. A few of crystalline limestone with serpentine, and a few of specular iron ore have been found which are like rock found in St. Lawrence county.

In many places, the drift hills have no definite direction, but those north of the great valleys of Seneca and Cayuga lakes are long elevated ridges, rising abruptly on the north, to a height of 50 or 60 feet, and sloping gradually down to their southern termination. The form of the hills is precisely such as would be made by a powerful current passing southward through these valleys, piling up the coarser materials at the northern extremity, and moving the finer ones farther on,

until they were in some measure protected by this barrier before they were deposited.

One of the most interesting of the superficial deposits is the Lake ridge, which, from Sodus in Wayne county, with some trifling exceptions, is a traveled highway nearly as far as the Niagara river. Beyond this it can be traced to the head of Lake Ontario. It follows the general course of the Lake; being at its nearest point about three miles distant, and at its greatest about eight miles. In some places it is strongly defined, descending toward the lake twenty or thirty and even fifty feet in a moderate slope. It consists of sand and gravel, and contains fragments of wood and shells, and in every respect it resembles the sea beaches. It was undoubtedly the ancient beach of Lake Ontario, or a body of water which once stood at this elevation. The top of the lake ridge is 158 feet above Lake Ontario at Lockport; 185 feet at Middleport, and 188 feet at Albion and Brockport.

Beside this well-defined ridge or ancient beach there are a number of less distinctly defined terraces of gravel and sand at much higher elevations, on the hill sides, leading to the supposition that the water of the Lake stood more than 750 feet higher than at present, or that the country has been correspondingly depressed.

Prof. W. W. Mather* found that the drift scratches, grooves and furrows conform in their directions to those in which currents would flow, if the country were mostly covered by water. In some parts, they correspond in direction to the main water-sheds; in others they do not, but where they do not, the deviation is owing to some topographical feature which disturbed the course of the currents of water.

In 1845, Alexander Murray† found the drift of western Canada, consisting of various beds of clay, sand and gravel, interspersed with large bowlders. The thickness frequently reaches 200 or 300 feet. The clay cliffs of Scarborough, are 320 feet. The ridges running parallel to the north shore of Lake Ontario, are 200 or 300 feet, and the highlands in Oxford, are 100 or 200 feet, and even more, and the banks of Grand river often expose a considerable amount of drift. The southern shores of lake Simcoe, are extensive sandy plains, which are in many places thickly strewed with bowlders, and bear proof of having once been the bottom of the lake. Wherever gravel is found, its pebbles consist of limestone, and with the larger fragments of that formation, they contain the fossils of the calcareous strata at Rama on the north. The

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* Geo. of the 1st Geological Dist., N. Y.

† Geo. Sur. of Canada.

whole formation consists of the disintegrated rocks of the immediate locality, or those at no great distance north. The grooves and scratches upon the rocks between Niagara and Hamilton, have a north and south direction.

In 1847, W. E. Logan* found on the north shore of Lake Superior, about three miles below the Petits Ecrits, six terraces, in addition to the summit, which, presenting a level surface throughout the whole length, may be considered a seventh. Blocking up the extremity of a deep cone from the rock on one side to that on the other, the accumulation is a barrier to an extensive flat and marshy surface, that spreads out in a valley behind, down to the level of which there is a rapid slope from the summit of the drift, at a distance of about 1,000 yards from the margin of the lake. The height of the ancient beaches as measured by a pocket spirit-level is as follows:

	Above the Lake. Feet.	Above the Sea. Feet.
1st Beach..............................	30	627
2d "	40	637
3d "	90	687
4th "	224	821
5th "	259	856
6th "	267	864
7th " or summit......................	331	928

The 3d and 4th beaches are the most decidedly marked, the steps, rising behind them, sloping up at an angle of nearly 30°.

Alexander Murray† described the drift on the Kamanitiquia river, which flows into Lake Superior, near Fort William, as consisting between McKay's mountain and the Grand Falls, where the principal display was found, of a light buff-colored clay, covered over by stratified yellow ferruginous sand, both together attaining a thickness of 60 feet above the level of the water. Banks of sand were found on Dog river, at a much higher level than the deposit further down.

In 1848, John L. Leconte‡ described, from a Post-pliocene deposit in a crevice in northern Illinois, *Platygonus compressus* and *Anomodon snyderi.*

Mr. Charles Whittlesey§ designated the different beds of the drift in Ohio and the West as follows :

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* Geo. Sur. of Canada.

† *Ibid.*

‡ Am. Jour. Sci. and Arts, 2d ser., vol. v.

§ *Ibid.*

1st. "Blue hard pan," resting unconformably on the surface of the stratified rocks. This is a very compact mass of *blue clay*, *marl* and *sand*, including great numbers of small, partially water-worn, *crushed* and *striated pebbles*, principally fragments of blue limestone and primitive rocks. It contains lime, so much as to effervesce with acids, and to hasten vegetation when applied to land. Beside its strong *blue color*, it is characterized by *imbedded timber*, dirt beds, leaves, sticks, and what are called by well diggers "grape vines." It is so solid as to be almost impervious to water, and is very difficult to excavate.

2d. "Yellow hard pan," resting unconformably on the stratified rocks, and the "blue hard pan." This is a compact material, of a *dull yellow color*, with fewer stony fragments or pebbles, and less calcareous and more aluminous matter than the blue hard pan. It is not quite as solid as the blue, more pervious to water, and contains more and larger pieces of primitive rocks. The clays of the country, used for bricks are principally of this bed. It forms a hard, stiff soil, adapted for grass. The flat regions and savannas of the northwest quarter of the State, are caused by the surface presence of this bed.

3d. "Sand and gravel drift," containing granite bowlders (in small numbers), of large size, and unconformable to Nos. 1 and 2, and the other rocks. It exhibits little regularity of stratification, is composed of inferior patches of coarse sand and gravel, intermingled at all inclinations, evidently the result of long continued and vigorous action of water in rapid motion. The gravel is coarse, but much *worn*, *rounded* and *smooth*, like the gravel beds of rapid streams. The portion of earthy matter is about one half, of a reddish and yellowish color, showing the presence of oxide of iron, and containing various proportions of sand and clay. Almost every rock in the northern part of America is represented in the gravel; but the greatest part by far is from the underlying and adjacent strata. There are pebbles of quartz, trap, granite, gneiss, conglomerate, limestones of all ages, iron ore, slate, coal and sandstone. In this there has been found timber but very rarely.

4th. The "valley drift," composed principally of debris of the adjacent rocks, and occupying the lower parts of the great valleys of drainage. It is more gravelly and less earthy, and the gravel is more of local origin than in No. 3, while the beds of sand are less common. It is in the "valley drift" or swamp mud that the bones of the mastodon and other large animals are usually found.

5th. "Lacustrine deposits," occupying the basin of the lakes, and for Lake Erie, divided into the "blue marly sand," and the coarse sand and gravel. The "blue marly sand," commonly called the blue clay of Lake Erie, is seen skirting the shore almost everywhere, if the coast is not rocky,—its upper face nearly horizontal, and rising from forty-five to sixty feet above the water. It is of a light blue color, so fine as scarcely to show between the fingers any grit, homogeneous, and in a dry state compact, but brittle. Very rarely, may be seen a primitive pebble, thin layers of leaves and lignite. It is distinctly and horizontally laminated, and at Cleveland is composed of about 75 per cent. impalpable sand, 3 per cent. iron, 6 to 7 per cent. carbonate of lime, 9 per cent. carbonate of magnesia, and of vegetable matter and sulphur. It is impervious to water, and thus causes thousands of springs to appear at its surface, which, passing out over the edges, dissolve and carry it away very fast, forming a quick sand. Its edge is presented to the action of the waves, which dissolve and carry it away rapidly. As it is not tenacious like clay, and not capable of sustaining itself under its own weight, and that of the sand stratum that rests upon it, there are continual breaks and slides along the banks, on both the American and Canadian shores. These avalanches of earth are from one to four rods in width, breaking off in irregular patches, and sometimes sinking, in a night or in a few hours, twenty or thirty feet, leaving huge fissures through which the water of the springs passes, and rapidly washes the earth into the lake.

At the water's edge, the slide frequently raises a bank of about the width of the break, several feet above the surface, driving back for a short time the line of the shore. But the waves acting incessantly dissolve the new barrier, and soon commence their attacks upon the body of the fallen mass, which disappears, and is before long followed by a fresh avalanche from above.

At the city of Cleveland, where the bluff shore rises 70 feet above the lake, the encroachment since the survey of the town in 1796, has been at the foot of Ontario street, 265 feet. The Canadian shore, from Detroit river to Long point, is losing faster than the American. Between Port Stanley and Port Burwell, on the British side, the superior face of the blue marl is about sixty feet, or fifteen feet higher than at Cleveland, and has in the upper part a lighter or more yellow color. In composition the yellowish portion is more argillaceous than the bright blue, and appears to correspond with the yellow clay stratum of Lake Champlain. The greatest thickness of the blue marls can not be com-

puted, as a large part of it lies below the lake level, forming the bed of more than one half of Lake Erie. On the south shore it extends but a short distance into the interior, forming a narrow belt of low country along the lake, and thinning out as the rocks upon which it rests rise to the southward.

The "coarse sand and gravel" of this division, rests conformably on the "blue marly sand," and spreads horizontally over a tract of low, and in general wet land, embracing the western half of Lake Erie, and extending westward into the States of Ohio and Michigan.

On the north, it forms the soil and surface over a large portion of the peninsula, between Lakes Erie and Huron; which seldom rise more than 200 feet above the waters of these lakes. On it, and composed of its coarse water-washed sand and gravel, are seen the "lake ridges," objects of curiosity, and of much utility in a new country, being natural turnpikes that run parallel with the shore. At Cleveland the section is as follows: 1st. Gray, water-washed, coarse sand, resting on the blue marl, 10 feet. 2d. Coarse gravel of the adjacent rocks and sand, 20 to 40 feet. The lake ridges are not precisely horizontal, and are found at *various* elevations, 30, 90, 120 and 140 feet above the water.

There are branches and cross ridges uniting different parallels, that rise and fall several feet in a mile.

6th. Bowlders or "erratic rocks" which he regarded as a "stratum," and the newest of all beds except the alluvium.

The Drift deposits* are very extensive on the southern shore of Lake Superior, and more especially on its southeastern coast. There they not only constitute the only visible formations for nearly 100 miles, but they also attain an astonishing thickness, so as to form, by themselves, ridges and cliffs which exceed in height even those of the Pictured Rocks, being in some places, as at the Grand Sable, not less than 360 feet high. The Drift is less conspicuous along the western portion of the lake shore, although it is not wanting even among the romantic and precipitous cliffs of the Pictured Rocks and the Red Castles.

The Drift of lake Superior may be divided in ascending order, into—

1st. Coarse drift. This is the least conspicuous of all. It is found only in a few places along the southern shore, generally capping the high towering cliffs of sandstone. It is generally a mixture of loam and fragments of rock of different sizes—sometimes worn, but more generally angular. As a leading feature, it is almost exclusively com-

* Foster and Whitney's Sur. Lake Sup. Region, 1850.

posed of fragments of the rocks *in situ*, showing that, whatever may have been its origin, it could not have been acted upon by long continued agencies. A few foreign pebbles exist in it, generally trap, and evidently derived from the neighborhood. Greatest thickness 30 feet.

2d. Drift clay, or red clay. It is a mixture of loam and clay, and its color is owing to the decomposition of the red sandstone and trap from which it has been derived. It is mainly composed of very finely comminuted substances, yet there are pebbles interpersed through it,and even bowlders of considerable size, generally rounded and smoothed. Fragments of metallic ores and native copper occur occasionally in it—the latter sometimes weighing several hundred pounds. It is found along the whole southern coast of lake Superior, resting upon the red sandstone, and limited to a certain height, but on the Ontonagon and Carp rivers, it is found in depressions on elevated lands, 500 feet above the lake. At Grand Sable where its base rests on almost horizontal strata of red sandstone, a few feet above the water, and its top is covered by a mass of drift sand, it is 60 feet in thickness, and exhibits lines of stratification disposed with great regularity.

3d. Drift sand and gravel. This is the most widely diffused of the drift deposits on the shores of lake Superior and the northern part of Michigan. The greatest thickness observed is at Grand Sable, where it is 300 feet thick.

4th. Bowlders. These occur of every size and description in great numbers along the whole southern shore. The largest noticed being of hornblende, and measuring 15 feet in length, 11 in width, and 6½ in height. The bowlders have been moved from north to south, but have not come from far, though some of them have been transported from the north shore. It is noticed among the ridges north of Carp river, that the valleys, for the most part, contain bowlders from the next ridge to the north; and there are instances where a ridge did not allow the fragments of the preceding ridge to pass. This limitation prevails only within the hilly portion of the Lake Superior region between the lake shore and the dividing ridge. South of this ridge no barrier occurs.

5th. Drift terraces and ridges. These may be seen both on the north and the south sides of Lake Superior, but they are less striking than around Lakes Erie and Ontario. They are most conspicuous on the south shore, between Saut and Keweenaw point. Their average height is about 100 feet. At a place two miles east of Two-hearted river, the following succession occurs: gravel beach, 5 feet; sand

beach, 12 feet ; 1st drift terrace, 29 feet; 2d drift terrace, 46 feet; 3d drift terrace, 75 feet ; summit of plateau, 94 feet.

The rocks in many places are grooved, scratched and polished. These phenomena, of course, can be seen only where the drift deposits are absent. The groovings consist generally of parallel furrows, from one to four lines wide—sometimes extending a foot, at others many yards. Where the rock is very hard, they are mere striæ. Hollow spots occur, as if they had been scooped out by a round instrument, and also wide bowl-shaped depressions, known as troughs, which have been caused by the same agency. Grooves and scratches were observed on the road from Eagle river to the Cliff mines running N. 15° E. On an island east of Dead river there are two systems of striæ—one running N. and S., and the other N. 20° E. and S. 20° W. The rock here which is very hard and tough hornblende, is not only grooved and furrowed over its whole extent, but there are, beside, deep trough-like depressions, with perfectly smoothed walls, some 12 to 15 feet long, 4 feet wide, and 2½ feet deep. On Middle Island, east of Granite point, troughs may also be seen 4 feet wide, and 2 feet deep, running like the striæ N. 20° E. On the promontories and islands near Worcester, two miles west of the mouth of Carp river, there are two distinct sets of striæ ; those running N. 55° E. are the most numerous ; those running N. 5° E. the least. The latter cross the former and are therefore more recent. Some of them are, beside, distinctly curved, as if the body which produced them had been deflected in ascending the slope. Each set of striæ extends only about one foot below the water's edge. On the first quartz ridge, one mile from the mouth of Carp river 500 feet high, the striæ run N. 20° E. On the iron ridge south of Teal lake, 750 feet high, the striæ run N. 55° E. At the Jackson forge N. 65° E. A green magnesian rock, with vertical walls, and semi-cylindrical form, on the road leading from Jackson landing to Teal lake is covered with striæ which may be traced along the surface, like hoops around a gigantic cask. On Isle Royal the striæ run N. 50° E. with many local deviations. On the shores of Ackley bay striæ near the water's edge running E. and W., cross others running N. E. and S. W., and others again running S. 75° E. Isle Royale presents but little evidence of drift, though scattered bowlders are found upon it; the surface of the rock s are generally, however, smoothed, as if polished off.

Mr. E. Desor described the superficial deposits on the northern shore of Lake Michigan, the western shore of Green bay, the Big Bay

des Noquets, and the valleys of the Menomonee and Manistee. The coarse drift described as occurring beneath the drift proper, at several points along the shore of Lake Superior, seems to be entirely wanting in this district.

Starting from Mackinac westward, the furrows and striæ were noticed at the bottom of St. Martins bay, and two miles north of Pine river, on a point composed of almost horizontal ledges of limestone, having an average direction from E. to W., some running N. 80° E., and others S. 70° and 80° E. At Payment point the direction being from N. 50° to N. 60° E. At the bottom of Big Bay des Noquets, on the west shore of the eastern cove, the direction is E. and W. At the mouth of the Escanaba, in Little Bay des Noquets, the direction is N. E. and S. W. At Oak Orchard, on the west shore of Green bay, the direction is N. 15° to N. 20° E. At the saw mill, near the mouth of the Menomonee, the direction is E. and W.; six miles above Kitson's trading house, E. N. E. and W. S. W.; three miles above Sturgeon's falls, N. 65° E.; foot of the Lower Bukuenesec falls, N. 70° E.; Lower Twin falls, N. 60° to N. 70° E.; and at Upper Twin falls, N. 65° to 70° E. From Green bay, southwestward, they were noticed at Mehoggan point, N. E. by E. and N. N. E.; at Mehoggan falls, N. E. by N.; three miles west of Milwaukee, N. E.; and at Strong's landing on Fox river, N. E. by E.

The true drift seldom approaches the shores of Lake Michigan and Green bay, but it is met with in ascending the rivers at no great distance. Its absence from the coast is the result of subsequent denudation, when the waters of the lake stood at a higher level than at present. It was observed at Pointe aux Chenes, and for a distance of six miles toward Payment point, and on Potawatomee and some of the higher islands. The thickness at Green bay was found on boring to be 108 feet.

Near the junction of the Machigamig and Brule, where the united streams take the name of Menomonee, the river banks are composed of drift, forming bluffs 100 feet or more in height. The drift is composed of sand and layers of gravel more or less interspersed through it, and covered more or less with bowlders. The higher lands adjoining are covered with the same materials. The country adjacent to the Manistee is likewise covered with the drift sand and pebbles. The whole country drained by the White-fish and its branches, and the Escanaba is likewise covered with the drift. The drift clay is well marked, in many places, below the drift sand, especially upon the

Manistee, where it does not generally reach more than 4 or 5 feet above the river, although in one place it was found 10 feet thick. It is very tough, and generally flesh colored, but in one instance it was perfectly white. There were observed, in several localities, rather coarse pebbles of limestone, and even flat stones intermixed with the upper layer of clay, near its contact with the sand.

He described the terraces on the island of Mackinac and the neighboring coasts, on the west coast, and at Pointe St. Ignace and Gros Cap on the north coast of Lake Michigan, which vary in height from 20 to 130 feet. But the terraces are not found farther west on the north shore of Lake Michigan and Green bay, nor in the vicinity of the Menomonee and Manistee.

Mr. Charles Whittlesey,* said of the terraces bordering Lake Erie, that the first ridge, or that nearest the lake, is known as the "North ridge." From Conneaut, in Ashtabula county, to Russelton, Huron county, a distance of 120 miles, the elevation of the ridge above the lake varies from 85 to 145 feet. The second ridge, from Kingsville, in Ashtabula county, to Ridgeville, in Lorain county, varies from 122 to 168 feet above the lake. These ridges consist of coarse, water-washed, yellowish sand, or of fine gravel, principally the comminuted portions of the adjacent rocks. The rocky fragments are not generally worn perfectly round, or oblong, as beach shingle is, but are more flat, with worn edges. There are mingled with the sandstones and shales that compose this gravel, scattered pieces of quartz, flint, granite, trappean rocks, limestone and ironstone. The third and fourth ridges are a little higher, and composed of coarser material.

In 1852, Charles Whittlesey† described the drift in that part of Wisconsin bordering on Lake Superior, and lying between the Michigan boundary and the Brule river, and the sources of the streams flowing into Lake Superior from the south. He divided the drift into—1st, red marly clay; 2d, bowlder drift, coarse sand and gravel.

The red marly clay is a fine-grained, homogeneous marly sand, cemented by argil or clay, with well defined horizontal lines of lamination or deposition; containing, but very rarely, pebbles of granitoid, trappose, sandstone, conglomerate, or slate rocks. This constitutes the shore or lake bluffs most part of the way from the Montreal to the Brule; the red sandstone, on which it rests, showing itself occasionally beneath. It is easily washed away in suspension by the waves, and

* Am. Jour. Sci. and Arts, 2d ser., vol. x.

† Owen's Geo. Sur., Wis., Iowa, and Minn.

having little tenacity, falls in slides and avalanches into the water, and is thus cut into deep, narrow gullies by rains. Its surface in the above district is not more than 250 feet above the lake, sloping gradually from the mountains to the shore, as though it formed, at one time, the bed of an ancient sea. On the waters of the St. Louis river on the west, and the Ontonagon on the east, however, the red clay deposits reach to the height of 450 to 500 feet above the lake.

On the "Isle aux Barques" the lime is so abundant in the clay, that it has formed in amorphous concretions throughout the mass. A few leaves and decayed sticks have been seen in the red marly clays, with carbonaceous matter and lignite, but such occurrences are rare. Along the coast there are interstratified beds of sand and gravel of a local character. In the interior, where the clay is visible in bold bluffs, along the water courses, it is more uniform and less intercalated with coarse drift. It rests not only on the sedimentary unaltered rocks, but also on trap and metamorphic and igneous rocks.

The mass of the hills between Chegwomigon bay and the Brule river, is gravel and bowlder drift. It is not very uniform in composition, and is marked by the violent action of water. The central part of this peninsula presents large tracts of barren, water-washed land, and moderately coarse gravel. Both the western and eastern knobs and ridges are of coarse materials; and toward the point or extremity about the "detour," and the adjacent islands, the sand and bowlder deposits are represented.

A section of three miles from the coast to the mountains, four miles southwest of La Pointe, showed red marly clay 95 to 130 feet above the lake, capped by coarse bowlder drift, the top of which is 428 to 509 feet above the lake. This drift is disposed in three very abrupt and well defined terraces. These terraces continue southward around the southern extremity of the mountain, and have the appearance of ancient beaches or shores.

In 1855, Prof. G. C. Swallow* found a fine, pulverulent, absolutely stratified mass of light, grayish buff, silicious and slightly indurated marl, capping nearly all the bluffs of the Missouri and Mississippi within that State, for which he proposed the name Bluff formation. The Bluff above St. Joseph exhibits an exposure 140 feet thick. It is easily penetrated by the roots of trees, which decay and leave encrusting tubes, giving it a peculiar perforated appearance. It extends from Council Bluffs to St. Louis, and below to the mouth of the Ohio.

* Geo. Sur. of Missouri.

The greatest development is in the counties on the Missouri, from the Iowa line to Boonville. In some places it is 200 feet thick. At Boonville it is 100 feet thick, and at St. Louis only 50 feet.

The Bluff Group is older than the bottom prairie, and newer than the Drift. It gives character and beauty to nearly all the best landscapes of the Lower Missouri.

He found the drift abounding north of the Missouri river, and existing in small quantities as far south as the Osage and Meramec. Its thickness varies from 1 to 45 feet. The upper part, having the appearance of having been removed and rearranged by aqueous agencies since its first deposit, but before the deposit of the Bluff Group, is described as altered drift. The heterogeneous strata of sand, gravel, and bowlders, is called the bowlder formation; and below this, in some places, a third division exists, which is called the "pipe clay." It contains bowlders more or less dispersed through the upper part of it. It is found in Marion, Boone, Cooper, Moniteau, Howard and Monroe counties, varying in thickness from 1 to 6 feet.

William P. Blake* described the grooving and polishing of hard rocks and minerals by dry sand in the Pass of San Bernardino, California, and on the projecting spurs of San Gorgonia. he said, grains of sand were pouring over the rocks in countless myriads, under the influence of the powerful current of air which seems to sweep constantly through this Pass from the ocean to the interior. Wherever he turned his eyes—on the horizontal tables of rock, or on the vertical faces turned to the wind—the effects of the sand were visible; there was not a point untouched, the grains had engraved their track on every stone. Even quartz was cut away and polished; garnets and tourmaline were also cut and left with polished surfaces. Masses of limestone looked as if they had been partly dissolved, and resembled specimens of rock salt that have been allowed to deliquesce in moist air. These minerals were unequally abraded, and in the order of their hardness; the wear upon the feldspar of the granite being the most rapid, and the garnets being affected least, wherever a garnet or a lump of quartz was imbedded in compact feldspar, and favorably presented to the action of the sand, the feldspar was cut away around the hard mineral, which was thus left standing in relief above the general surface. A portion however, of the feldspar, on the lee side of the garnets, being protected from the action of the sand by the superior hardness of the gem, also stood out in relief, forming an elevated string, osar like, under their

* Am. Jour. Sci. and Arts, 2d ser., vol. xx.

lee. When the surface acted on, was vertical and charged with garnets, a very peculiar result was produced; the garnets were left standing in relief, mounted on the end of a long pedicle of feldspar, which had been protected from action while the surrounding parts were cut away. These little needles of feldspar tipped with garnets, stood out from the body of the rock in horizontal lines, pointing like jeweled fingers in the direction of the prevailing wind.

The effects of driven sand are not confined to the pass; they may be seen on all parts of the desert where there are any hard rocks or minerals to be acted upon. On the upper plain, north of the Sand Hills, where steady and high winds prevail, and the surface is paved with pebbles of various colors, the latter are all polished to such a degree that they glisten in the sun's rays, and seem to be formed by art. The polish is not like that produced by the lapidary, but looks more like laquered ware, or as if the pebbles had been oiled and varnished. On the lower parts of the desert, or wherever there is a specimen of silicified wood, the sand has registered its action. It seems to have been ceaselessly at work, and when no obstacle was encountered on which wear and abrasion could be effected, the grains have acted on each other, and by constantly coming in contact have worn away all their little asperities and become almost perfect spheres. This form is evident whenever the sand is examined by a microscope.

We may regard these results as most interesting examples of the denuding power of loose materials transported by currents in a fluid. If we can have a distinct abrasion and linear grooving of the hardest rocks and minerals, by the mere action of little grains of sand, falling in constant succession, and bounding along on their surface, what may we not expect from the action of pebbles and bowlders of great size and weight, transported by a constant current in the more dense fluid, water? We may conclude that long rectilinear furrows of indefinite depth may be made by loose materials, and that it is not essential to their formation that the rocks and gravel, acting as chisels or gravers, should be pressed down by violence, or imbedded in ice, or moved forward *en masse* under pressure by the action of glaciers or stranded icebergs. Wherever, therefore, we find on the surface of mountains, not covered by glaciers, grooved and polished surfaces with the furrows extending in long parallel lines seeming to indicate the action of a former glacier, we should remember the effects which may be produced during a long period of time by light and loose materials transported in a current of air; and which, consequently, may be pro-

duced with greater distinctness, and in a different style, by rocks moved forward in a current of water. The effects produced by glaciers, by drift, or moving sand, are doubtless different and peculiar, so different and characteristic, that the cause may be at once assigned by the experienced observer, who can distinguish between them without difficulty. It is, however, possible that after a sand worn surface, such as has been described, has been for ages covered with moist earth, a decomposition of the surface would take place sufficient to remove the polish from the furrows and leave us in doubt as to their origin.

Alexander Murray* examined a portion of the country between Georgian bay in Lake Huron, and the Ottawa river. He followed the course of the Muskoka river to its head, and by a short portage passed to the source of the Petewahweh, and by its channel descended to the Ottawa. Returning, he ascended the Bonnechere river to Round lake, from which he crossed to Lake Kamaniskiak on the main branch of the Madawaska, and descended the latter stream to the York or southwest branch, from whence he crossed to Balsam lake. He found stratified clays on the Muskoka, between the lake of Bays and Ox-tongue lake, at the height of about 1,200 feet above the level of the sea; the banks expose 10 or 12 feet in thickness, of drab or light buff-colored clays, alternating with very thin layers of fine yellow or grayish sand. At one place, the beds are tilted, showing a westerly dip of about eight degrees, in which they exhibit slight wrinkles or corrugations. Coarse yellow sand overlies the clay, and spreads far and wide over the more level parts, generally forming the bank of the river, where not occupied by hard rock. On the Petewahweh, especially below Cedar lake, the whole of the level parts are covered with sand, which, in some places, is of great thickness. Cedar lake is about 1,050 feet above the sea.

The banks of the Bonnechere display a great accumulation of clay at many parts below the fourth chute, sometimes exposing a vertical thickness of from 70 to 80 feet. Near the mouth of that river, below the first chute, where the clays form the right bank, and are upward of 50 feet high, they are chiefly of a pale bluish-drab color, and are calcareous, while other clays found higher up the stream, are of a yellowish-buff, and do not effervesce with acids. Below the second chute, buff-colored clay is interstratified with beds of sand and gravel, the latter sometimes strongly cemented together by carbonate of lime, the whole being overlaid by a deposit of sand. The gravel is seldom

* Geo. Sur. of Can., Rep. of Progr. for 1853.

very coarse, although an individual bowlder may occur here and there amongst it, and it is chiefly derived from the rocks of the Laurentian series. The height of the first chute above the sea, is 265 feet; the second chute, 348 feet; the fourth chute, including its fall of 39 feet, 432 feet; Round lake, 520 feet, or nearly 60 feet below Lake Huron.

Sand is extensively distributed over the plains of the Bonnechere, and over a large portion of the area between it and the valley of the Madawaska. Most of the valley of the Little Madawaska is covered with sand on either side, and the country between its head waters and Lake Kamaniskiak is one continuous sandy plain. The height of land in passing over the portage to the Madawaska is 968 feet above the sea, and Lake Kamaniskiak is 906 feet above the level of the sea. No organic remains have been detected in any of these drift deposits.

He, afterward,* surveyed the valley of the Meganatawan river and part of the coast or Lake Nipissing. Stratified clay was found on the banks of the Meganatwan, above the second long rapids, east of Doe lake. The color is a brownish drab; it is very tenacious, and does not effervesce with acids. The highest exposure is a little over 1,000 feet above the level of the sea. A fine, strongly tenacious clay occurs on the Nahmanitigong near the main elbow, where the upward course of the river turns to the south at an elevation of 710 feet above the sea. The color of the clay is chiefly pale drab or buff, but bands of reddish clay are interstratified and some of pale blue overlie the whole. The clays of the interior are usually overlaid by a deposit of coarse yellow sand. Among the bowlders on Lake Nipissing, many were observed to be of a slate conglomerate like that of the Huronian series, and they were frequently of very great size.

In the succeeding year† he explored portions of the Huron and western districts of the Province of Canada, and found that the course of the currents which had borne along the drift was from northwest to southeast. This is indicated by the pebbles and bowlders of metamorphic rocks which were clearly derived from the Laurentian and Huronian formations on the north shore of Lake Huron, and by the character of the fossiliferous rocks and pebbles which have been moved a shorter distance, and by the grooves and scratches which invariably have a bearing from the northwest to the southeast.

He, afterward,‡ made a survey north of Lake Huron, where he found

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* Geo. Sur. of Canada., Rep. of Prog., 1854.

† Rep. of Prog. for 1855.

‡ Rep. of Prog. for 1856.

bowlders derived from the Huronian rocks that had been moved from their source and transported southerly. In the valleys of the Wahnapitae and French rivers, large bowlders of conglomerate rest on the contorted gneiss at various elevations above the mark of the greatest floods, the highest probably over 100 feet. On the Sturgeon and Maskanongi rivers, and on Lake Wahnapitaeping, the course of the grooves and scratches is S. 27° W., with scarcely any deviation, but farther west they seem to alter their course to a more westerly direction, and on Round lake they bear S. 41° W.; while at the long lake, near the outlet of the White-fish river, their direction is S. 49° W. The great deposits of silicious sand, which are spread over the upper valley of the Wahnapitae, above Wahnapitaeping lake, and also the sand in the valley of the Sturgeon river, are probably chiefly derived from the ruins of the Huronian rocks. Lake Huron is 578 feet above the sea; Lake Wahnapitaeping, 938 feet; Round lake, 775 feet; Sturgeon river, at the junction of the Maskanongi, 809 feet; and Maskanongiwagaming lake, on the Maskanongi, 862 feet.

In 1859, he described* the drift north of Lake Huron, between the valley of the Thessalon river and the lake coast south of it, and between the valleys of the Thessalon and the Mississagui. A deposit of clay usually of a brownish drab color is spread over a large portion of the region, particularly in the hollows and valleys, and is frequently exposed on the banks of the streams, distinctly stratified, and in considerable thickness. The clay is overlaid with sand which extends far and wide over the highest table lands, and a great part of the country generally. The clay deposits of the Mississagui and Little White rivers, do not appear to attain a height of much more than 160 feet over Lake Huron. Above the Grand Portage at 154 feet above the lake, the clay is replaced by a great accumulation of sand and gravel, the gravel becoming coarser and more prevalent as we ascend the river. On the banks and flats above Salter's base line, 252 feet above the lake, the shingle consists of rounded masses almost all of Syenite, the smallest of which is rarely under the size of a man's fist, and the average as large as a twelve pound canon ball. Many of the masses are much larger, and in addition there are a great number of huge bowlders.

Grooves and scratches on the sides of the lakes, and in the valleys, have the same general bearing of the valleys, and follow the meanderings of the lake depressions. Instances are as follows: On the island

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* Geo. Sur. of Canada.

south side of Echo lake S. 55° W.; half a mile below S. 70° W.; in a depression north of Walker lake S. 17° W.; Thessalon river above Rock lake S. 25° W.; west and south sides of Rock lake S. 15° W.; east side of bay at Bruce Mines S.; northwest end of Wahbiquekobingsing lake S.; southeast end of same lake S. 12° W.

Instances* of the abraded and polished surfaces of rock are very numerous on the Canoe route from Lake Superior to Lake Winnipeg. Near Baril Portage, 143 miles from Lake Superior, and 1,500 feet above the sea, gneissoid hills and islands are smooth and sometimes roughly polished on the northerly side, while on the southern side they are precipitous and abrupt. On Sturgeon lake, 208 miles from Lake Superior, and 1,156 feet above the sea, the northeastern extremities of hill ranges slope to the water's edge, and when bare are always found to be smoothed and ground down. The aspect of the south and southwestern exposures, is that of precipitous escarpments. The summits of the granite hills near Lake Winnipeg are abraded and frequently so smooth and polished as to make walking upon them difficult, if not impossible in moderately steep places.

On the south branch of the Saskatchewan the drift is exposed in cliffs 50 to 80 feet in altitude at the bends of the river. The drift consists of clay with long lines of bowlders in it at different elevations. Some of the fragments of shale, slabs of limestone and small bowlders imbedded in the clay, stand in the drift with the longest axis vertical, others slanting, and some are placed as it were upon their edges. Long lines of bowlders lie horizontally from ten to twenty feet below the surface or top of the cliff, while below, in many places, close to the water's edge, and rising from it in a slope for a space of 25 to 30 feet, the bowlders are packed like stones in an artificial pavement, and often ground down to a uniform level by the action of ice, exhibiting ice grooves and scratches in the direction of the current. This pavement is shown for many miles in aggregate length at the bends of the river. Sometimes it resembles fine mosaic work, at other times it is rugged, where granite bowlders have long resisted the wear of the ice, and protected those of softer materials lying less exposed.

Two tiers of bowlders, separated by an interval of 20 feet, are often seen in the clay cliffs. The lower tier contains very large fragments of water-worn limestone, granite and gneissoid bowlders, above them is a hard sand containing pebbles; this is followed by an extremely fine stratified clay, breaking up into excessively thin layers, which

* Assiniboine and Saskatchewan Expl. Exped.

envelope detached particles of sand, small pebbles and aggregations of particles of sand. Above the fine stratified clay, yellow clay and unstratified sand occur.

Bowlders are found on the Qu'Appelle and its affluents, below the Moose Woods, and north of the Assiniboine, measuring from 10 to 25 feet or more in diameter.

In Lake Winnipeg, ice every year brings vast bowlders and fragments of rock of the Laurentian series, which occupy its eastern shores, and distributes them in the shallows and on the beaches of the western side. In Lake Manitobah, long lines of bowlders are accumulating in shallows and forming extensive reefs; the same operation is going on in all the lakes of this region, and is instrumental in diminishing the area of the lake in one direction, which is probably compensated by a wearing away of the coast in other places.

A remarkable beach and terrace, showing an ancient coast line between Lake Superior and Lake Winnipeg, separates Great Dog from Little Dog lake on the Kaministiquia canoe route. The Great Dog portage, 55 miles from Lake Superior by the canoe route, rises 490 feet above the level of the Little Dog lake, and the greatest elevation of the ridge can not be less than 500 feet above it. The difference between the level of Little and Great Dog lakes, is 347.81 feet, and the length of the portage between, one mile and 53 chains.

The base of the Great Dog mountain consists of a gneissoid rock, supporting numerous bowlders and fragments of the same material. A level plateau of clay then occurs for about a quarter of a mile, at an altitude of 283 feet above Little Dog lake, from which arises, at a very acute angle, an immense bank or ridge of stratified sand, holding small water-worn pebbles. The bank of sand continues to the summit of the portage, or 185 feet above the clay plateau. East of the portage path the summit is 500 feet above Little Dog lake.

Here we have a terrace 500 feet above Little Dog lake, or 863 feet above Lake Superior, or 1,463 feet above the sea. Another beach or terrace occurs at Prairie portage, 104 miles by the canoe route from Lake Superior, 190 feet above Cold Water lake, or 900 feet above Lake Superior, or over 1,500 feet above the sea.

In the valley of Lake Winnipeg, the first prominent beach or terrace is the Big ridge. Commencing east of Red river, a few miles from the lake, it pursues a southwesterly course until it approaches Red river, within four miles of the Middle settlements; here it is $67\frac{1}{2}$ feet above the prairie; on the opposite side of the river, a beach on Stony moun-

tain corresponds with the Big ridge, and beyond it forms the limit of a former extension of Lake Winnipeg. On the east side of Red river the Big ridge is traced nearly due south from the Middle settlement to where it crosses the Roseau, 46 miles from the mouth of that stream, and on or near the 49th parallel. It is next met with at Pine creek, in the State of Minnesota, and from this point it may be said to form a continuous level gravel road, beautifully arched and about 100 feet broad, to the shores of Lake Winnipeg, 120 miles. On the west side of Red river, north of the 49th parallel, and north of the Assiniboine, from a point near Stony mountain, it extends to near Prairie Portage, where it has been removed by the Prairie Portage river and the waters of the Assiniboine. It may be seen again on White Mud river, about 20 miles west of Lake Manitobah.

In the rear of Dauphin lake, the next ridge in ascending order occurs; it forms an excellent pitching track for Indians on the east flank of the Riding mountain. At Pembina mountain four distinct steps or beaches occur, the summit of which is 210 feet above the prairie.

The lower prairies enclosed by the Big Ridge are everywhere intersected by small subordinate ridges which often die out, and are evidently the remains of shoals formed in the shallow bed of Lake Winnipeg, when its waters were limited by the Big ridge. The long lines of bowlders exposed in two parallel, horizontal rows, about 20 feet apart, in the drift of the south branch of the Saskatchewan above mentioned, are the records of former shallow lakes or seas in that region.

They may represent a coast line, but more probably low ridges formed under water, upon which bowlders were stranded. The fine layers of stratified mud, easily split into thin leaves, which lie just above them, show conclusively that they were deposited in quiet water; their horizontality proves that they occupied an ancient coast or ridge below the comparatively tranquil water of a lake of limited extent; the vast accumulations of sand and clay above them establish the antiquity of the arrangement; and the occurrence of two such layers, parallel to one another, and separated by a considerable accumulation of clay and sand, leads to the inference that the conditions which established the existence of one layer also prevailed during the arrangement of the other. It may be that these are bowlders distributed over the level floor of a former lake or sea, and they may cover a vast area.

The Pembina mountain is par excellence the ancient beach in the valley of Lake Winnipeg. It is not a mountain, nor yet a hill. It is a

terrace of table land, the ancient shore of a great body of water, that once filled the whole of the Red river valley. It is only 210 feet above the level of the surrounding prairie, or between 900 and 1,000 feet above the ocean level. High above Pembina mountain the steps and plateaux of the Riding and Duck mountains arise in well defined succession. On the southern and southwestern slopes of these ranges the terraces are distinctly defined, on the northeast and north sides the Riding and Duck mountains present a precipitous escarpment which is elevated fully 1,000 feet above Lake Winnipeg, or more than 1,600 feet above the sea. One of the terraces here is 1,428 feet above the level of the ocean. The denudation of the Cretaceous, in the valley of Lake Winnipeg, has been enormous, because the shales crop out 500 feet above Dauphin lake, where their position is nearly horizontal, and evincing their former extension to the northeast, if not as far as the north shore of Lake Winnipeg. Sand hills and dunes occur on the Assiniboine, Qu'Appelle, South Branch, and north of Touchwood hills.

Prof. E. W. Hilgard† described the drift (he called it the Orange Sand formation) as covering the greater part of the State of Mississippi. It is overlaid by the Bluff Group, and is not, therefore, above Natchez, exposed on the surface, within eight to twelve miles of the Mississippi river ; below Natchez, however, it forms the White cliffs on the Mississippi itself. It does not cover the northeastern part of the State, and is absent from other limited patches. The thickness is quite variable, sometimes reaching 200 feet, though usually not more than 40 to 60 feet. The material is usually silicious sand, colored more or less with hydrated peroxide of iron, or orange-yellow ochre. Sometimes pebbles or shingle, either cemented into puddingstone, or more frequently loose and commingled with sand or clay occur, and at other times limited deposits of clay are found. It contains fossils from the Silurian, Devonian, Carboniferous, and Cretaceous formations which are exposed to the north in Tennessee, Kentucky, Indiana, Illinois and Ohio, and silicified wood from the lignite strata of Mississippi. The character of the surface upon which it rests its own irregular stratification, and the dependence, to a great extent, of the nature of its materials, upon that of the underlying formations, proves, beyond question, that its deposition, preceded and accompanied by extensive denudations, has taken place in flowing water, the effect of whose waves, eddies and counter currents, is plainly recognizable in numerous profiles. Nor can there be any doubt that the general direc-

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* Geo. Sur. of Miss.

tion of the current was from north to south, although locally changed or directed by the pre-existing inequalities of the surface.

The drift is succeeded on the Mississippi by a narrow belt, called the Bluff Group, but in other parts of the State the drift is covered by a yellow loam, which also succeeds the Bluff. The second bottom, or Hommock deposits, and the alluvial, are yet more recent in their character.

Drift materials* are strewn over a great part of the surface of Michigan. At East Saginaw these materials are from 90 to 100 feet thick, and at Detroit 130 feet thick. Wherever large surfaces of the underlying rocks are exposed, they are found to be more or less smoothed and striated. The island of Mackinac shows the most indubitable evidence of the former height of the water, 250 feet above the level of the lake. The trunks of white cedar trees are not uncommon in the drift, and on the north shore of Grand Traverse bay there is a bed of lignite.

In 1862, Prof. J. D. Whitney pointed out,† approximately, the territory in northern Illinois, western Wisconsin, northeastern Iowa, and eastern Minnesota, that is destitute of drift. This tract is several hundred miles in length, and from 100 to 200 miles in width. There is an entire absence of bowlders or pebbles, or any rolled and waterworn materials, which by their nature would indicate that the region in question had been exposed to the action of those causes by which the drift phenomena were produced. The surface of the rock is uneven and irregular, bearing the marks of chemical rather than of mechanical erosion, and there are no furrows, striæ or drift scratches, such as may be observed on many of the rocks over which the drift has been moved.

He concluded:

1st. That there has existed, ever since the period of the deposition of the Upper Silurian, a considerable area, chiefly in Wisconsin and near the Mississippi river, which has never been sunk below the level of the ocean, or covered by any extensive and permanent body of water, and which, consequently, has not only not received any newer deposit than the Upper Silurian, but has also entirely escaped the invasion of the drift, which took place over so vast an extent of the northern hemisphere.

2d. That the extensive denudation, which can be shown to have taken place in this region, as witnessed by the outliers of rock still remaining, and the general outline of the surface, has not been occasioned

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* Geo. Sur. of Mich., 1861.

† Geo. Sur. of Wisconsin.

by any currents of water sweeping over the surface, under some great general cause, but that it has all been quietly and silently effected by the simple agency of rain and frost, acting uninterruptedly through a vast period of time.

3d. That a large portion of the superficial detritus of the West, even in those regions where drift bowlders are met with, must have had its origin in the subærial destruction of the rocks, the soluble portion or them having been gradually removed by the percolating water, while that which remains represents the insoluble residuum, the sand and clay, which was originally present in smaller quantities in the strata thus acted on.

Bowlders of Laurentian rocks* are found in considerable numbers scattered over the high table-land of western Canada, south of Georgian bay. A portion of this region attains an elevation of 1,760 feet above the sea. These blocks are generally more angular than those from a similar source found at lower levels, and are associated with many others of local origin.

The stratified drift is separable into two divisions in western Canada, the lower of which, called the Erie clay, had been partially worn away before the deposition of the upper so as to produce unconformability. The Erie clay is commonly more or less calcareous, and always holds bowlders in greater or less abundance. The thickness at any one place does not exceed 200 feet, but clays belonging to this division occur at various levels from 60 feet below the surface of Lake Ontario to 100 feet above Lake Huron, showing differences in level of about 500 feet. It occurs along the north shore of Lake Erie from Long Point westward to the Detroit river, and appears to underlie the whole country between this part of the lake and the main body of Lake Huron. It is found at Owen sound, and along Nottawasaga river, and along the shores of Lake Ontario as far east as Brockville. The upper division is called the Saugeen clay, because it is well exposed along the Saugeen river. It consists of a thinly-bedded, brown calcareous clay, generally containing but few bowlders or pebbles. This division occurs also at all levels from Lake Ontario to 100 feet above Lake Huron, showing differences of level almost equal to that of the lower clay.

At the oil wells, on the 13th and 14th lots of the 10th range of Enniskillen, two beds of gravel, of four and five feet respectively, have been met with in the clay, at depths of ten and forty-four feet from the sur-

* Geo. Sur. of Canada, 1863.

face, making a total section of clay and gravel of 49 feet. *Unio circulus*, *U. gibbosus*, and valves of a *Cyclas* were found in the upper bed of gravel, and a deer's bone was said to have been found also. Between the gravel and the overlying 10 feet of clay, a thin layer of impure mineral pitch, or half dried petroleum, intervenes, inclosing leaves of land plants, and occasionally insects. Fresh-water shells occur in the clay on the Detroit river. At Niagara Falls the Silurian limestone is covered by 120 feet of sandy loam, holding striated pebbles and small bowlders, and containing near the middle the shells of a species of *Cyclas*. It is overlaid by fifteen feet of thinly-bedded, reddish-brown clay, containing similar pebbles and angular fragments. This deposit, whose summit is 60 feet above the level of Lake Erie, forms a bank which continues up to Chippawa. Valves of the *Cyclas* occur in the upper clay, in calcareous nodules, at a railway cut betwen Kingston and the Grand Trunk railway station, and leaves of a plant resembling *Vaccinium* occur in a laminated brownish clay at Newborough. At the upper termination of the town plat, on the right bank of the Goulais river, there is a deposit of the roots and limbs of trees, imbedded in a bluish scaly material, apparently a mass of compressed leaves and moss, which rests upon a bed of clay, and is overlaid by a mixture of clay and sand; the whole, with a stratum of sand at the top, constitutes a bank of from 20 to 24 feet high. The bed of vegetable matter, which is from one to three feet thick, and about ten feet over the river at the western end of the exposure, dips gently and evenly up the stream; while a thin bed of reddish clay, intervening between the overlying arenaceous clay, and the stratum of sand which forms the surface, seems to be perfectly horizontal. On the south side of Lake Superior, between White-fish Point and the Painted Rocks, a great deposit of sand, interstratified with gravel, is spread over the surface of the country. At the Grand Sable, a short distance west from the Grand Marais, it rises here and there almost vertically from the lake to a height of 300 feet. A bed of vegetable matter occurs below a layer of mixed sand and clay, and beneath this hill of sand and gravel, which contains *Thuya occidentalis*, *Betula paperacea*, and *populus balsamifera*.

Behind the Sault Ste Marie, a terrace, varying in its height, but averaging perhaps 150 feet above Lake Superior, and often composed of clay in red and drab layers, stretches from the Laurentide hills southward toward the St. Mary river. About a mile below, and again about four miles above the foot of the Sault, this terrace comes near

the edge of the river, and recedes in sweeping curves in both directions from each of these points. A bay, two miles and a half in depth, is thus left between them, and is occupied by a barren plain of no great elevation above the river, partly covered with coarse brown sand, and partly strewn with bowlders of northern metamorphic rocks and angular fragments of Silurian sandstone, which are sometimes arranged in small bare ridges parallel to the present direction of the river. The surface has thus the appearance of having formerly been covered with swiftly flowing water.

To the north of Lake Huron, and between the Georgian bay and the Ottawa river, part of the surface of the country consists of bare rock, but where any superficial covering exists, it is almost invariably a yellow sand. A belt of loose gravel, remarkable for its great extent, stretches in a southward direction across the peninsula of western Canada, from near Owen sound to Brantford, a distance of 100 miles. Its average breadth is nearly 23 miles, and its total area more than 2,000 square miles. This great belt of gravel has a general parallelism with the Niagara escarpment, and consists in large part of the ruins of the underlying Guelph and Niagara Groups, though pebbles of the Huronian and Laurentian rocks are everywhere mixed with the others, and fragments of the Hudson River Group occasionally occur.

Beside these clays and sands there are several local accumulations in western Canada, often marked by fresh-water shells. These, together with various ridges and terraces, which are conspicuous features in the surface geology of this region, appear for the most part to have been formed by the waters of the great lakes, when their extent was much greater than at present. The most considerable deposit of this kind is the sandy tract in the county of Simcoe, which extends south-eastward from the head of Nottawasaga bay, and has an area of more than 300 square miles. *Unio complanatus*, *Cyclas dubia*, *C. similis*, *Amnicola porata*, *Valvata tricarinata*, *V. piscinalis*, *Planorbis trivolvis*, *P. campanulatus*, *P. bicarinatus*, *Limnæa palustris*, and *Physa ancillaria*, occur at from 30 to 40 feet above the level of Lake Huron, and twenty miles distant near the Nottawasaga river. *Planorbis trivolvis*, and three species of *Helix*, were found in sand and gravel in a road cutting through a little ridge between 75 and 78 feet above Lake Huron, about a mile south of Collingwood harbor. Two miles west of Cape Rich, worn fragments of bark and wood were met with in digging a cellar on a terrace 155 feet above the lake. There are several terraces of sand and gravel which correspond to ancient water margins on the

shores of Owen sound, at 120, 150 and 200 feet above the present level of Lake Huron, and some of the higher terraces continue with great regularity for several miles. Terraces and ancient beaches are found in many places upon Lake Superior. On the north side of the lake, the ancient water margins are frequently marked by the wearing of the solid rock as well as by the loose materials. In a sandy ridge near the western part of Lake Ontario, called Burlington heights, at the height of 70 feet above the lake, several bones of the mammoth were discovered, and in the same excavation, seven feet higher, the horns of the wapiti (*Cervus canadensis*), and the jaw of a beaver (*Castor fiber*), were also found.

The drift in Illinois* is divided into—1st, blue plastic clay, with small pebbles, often containing fragments of wood, and sometimes the trunks of trees of considerable size, which form the lower division of the mass; 2d, buff and yellow clays and gravel, and irregular beds of sand, with bowlders of water-worn rock of various sizes interspersed through the whole; and lastly, reddish-brown clays, generally free from bowlders, and forming the subsoil in those portions of the State remote from the streams, and where the loess is wanting. The scratched and grooved surfaces presented by the underlying limestones, at many localities, and the smoothly worn and polished surfaces that may be seen at others, and the immense size and weight of many of the transported bowlders, which have been carried for hundreds of miles from the nearest outcrop of the metamorphic beds to which they belong, alike preclude the idea that such results have been produced by the action of water alone. Huge masses of moving ice, like the icebergs of the present day, loaded with the mineral detritus of the far northern lands, with angular fragments of hard, metamorphic rock, firmly imbedded in the solid ice to act as a graver upon whatever rock surface they might come in contact, are the only known agencies that seem adequate to the production of the phenomena, characteristic of the drift deposits in this State.

There is an area in the southern part of the State, and another in the northwestern part of the State, over which the drift deposits do not extend. The lead region of Illinois, Iowa and Wisconsin was not invaded by the drift, and is, therefore, entirely free from accumulations of gravel, pebbles and bowlders, that characterize drift areas. The topographical features of the country have been produced by the quiet but

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* Geo. Sur. of Illinois, vol. i.

ceaseless agency of water, not sweeping over the surface in the mighty currents of the diluvial epoch, bearing the detritus of northern crystalline rocks, and grinding down and bearing away the softer strata, but falling as rain, percolating through the calcareous and magnesian deposits, and gradually carrying them off in solution, leaving the insoluble portion behind, in the form in which we now see it covering the solid rock, as an intimate mixture of the finest argillaceous and silicious particles.

The trunks and branches of coniferous trees, belonging, apparently, to existing species, are quite common in the blue clays at the base of the drift; and in the brown clays above, the remains of the mammoth, the mastodon, and the peccary are occasionally met with. The fine fragment of a mastodon's jaw, with the teeth, found at Alton, was obtained from a bed of drift, underlying the loess of the bluffs, which, at this point, was about thirty feet thick, and remained *in situ* above the bed from which the fossils were taken. Stone axes and flint spear-heads are also found in the same horizon, indicating that the human race was cotemporary with the extinct mammalia of this period. The bones and teeth of a great number of species are found in the crevices of the rocks in the driftless area of the lead region, where they have been washed from the surface, and carried in some instances fifty or sixty feet before finding a lodgment. The most abundant among the remains of animals thus found are those of the mastodon, whose teeth and bones have been procured from a great number of crevices, over the whole area of the lead region; showing that the species must have lived and flourished in immense numbers, and through a long period of time, since the chances of the preservation of the remains of any one individual by being washed into a crevice, must have been exceedingly small. The remains of both living and extinct species are found in the crevices in such positions, in reference to each other, as to indicate pretty clearly that they were living together. From a crevice, near the Blue Mounds, Prof. Worthen collected the bones and teeth of the mastodon, peccary, buffalo, and wolf—the two former extinct, and the two latter supposed to be identical with the living species.

In 1867, Prof. C. A. White* found drift scratches upon limestone of the Upper Coal Measures, in Mills county, Iowa, near the Missouri river, having a direction S. 20° E., and these crossed by a finer set of scratches, having a direction S. 51° E. And at an exposure of the same limestone, one mile below Omaha, the capital of Nebraska, imme-

* Am. Jour. Sci. and Arts, 2d series, vol. xliii.

diately upon the right bank of the Missouri river, and only six or eight feet above the ordinary stage of water, other scratches having a direction S. 41° E.

Prof. F. V. Hayden found erratic bowlders scattered over the country in northeastern Dakota, of all sizes and texture, and especially numerous in the valley of the James river and its tributaries.

In 1869, Dr. E. Andrews* said, that throughout Central Illinois the ancient Pliocene soil still lies undisturbed beneath the bowlder drift. This soil has been met with in excavations at so many independent points, that it may, probably, be considered as the usual floor on which the drift rests. Two of the best observations of it were obtained at Bloomington, Illinois. In sinking two coal shafts, the workmen first passed through 118 feet of unmodified drift clay, whose bowlders and pebbles were all of northern origin, and often scratched by the action of ice. Directly beneath this was a bed of ancient soil, on which logs of wood lay scattered confusedly about, and in which the stump of a tree still stood where it grew. Beneath the soil bed lay various sands, gravels, and clays, and a second dirt bed, but no more northern drift. The stump was of coniferous wood. All of the original drift is clearly stratified.

In 1873, Robert Bell† found the stiff red clay of the Kaministiquia valley, extending westward up the valley of the Mattawa to the outlet of Shebandowan lake, becoming apparently less abundant all the way, and finally disappearing on reaching the lake. Around the shores of this lake, and of nearly all the lakes passed, by way of Lonely lake and the English and Winnipeg rivers to Lake of the Woods, wherever the vegetation is burnt off, the rocky mammillated hills are seen to be strewn with rounded and angular bowlders, from the size of a man's head to a diameter of 30 to 40 feet. Many of these are perched in positions from which they look as if they might be easily rolled into the water below. The striæ on the surface of the rocks occur almost everywhere, and are very general in their course from south to southwest.

In 1875, Prof. George M. Dawson‡ found the striæ on the rocks at Lake of the Woods varying in their course from S. 20° E. to S. 87° W. Bowlders and traveled materials are spread over the country in this vicinity, and especially on the south side of the islands.

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* Am. Jour. Sci. and Arts, 2d ser., vol. xlviii.

† Geo. Sur. of Canada.

‡ Rep. Geo., 49th Parallel.

The drift deposits cover the second prairie plateau west of the Red river and Turtle mountain, and the eastern front of Pembina escarpment is distinctly terraced and the summit of the plateau thickly covered with drift. The first terrace is about 50 feet above the general prairie level, the second about 260 feet, and the third about 360 feet.

One hundred and twenty miles west of Turtle mountain, the second prairie plateau comes to an end against the foot of the great belt of drift deposits, known as the Missouri Coteau, a tumultuously hilly country, based on a great thickness of drift. The Missouri Coteau is a mass of debris and traveled blocks, with an average breadth of 30 to 40 miles, extending diagonally across the central region of the continent with a length of 800 miles. It appears to have been the work of sea-borne icebergs, and not glacier ice as such.

In 1876, Mr. Robert Bell* said, that in the prairie regions of the northwest territory, loose deposits of Post-Tertiary age cover the surface of the country almost universally, and they are usually of considerable depth. There are immense areas having the same general elevation, or without very great or sudden changes of level, yet, with the exception of the first prairie steppe, there is a remarkable scarcity, or perhaps absence, of extensive stratified deposits of sands and clays, such as occur in the provinces of Ontario and Quebec. The bulk of the superficial deposits is of the nature of bowlder-clay or unmodified drift, which is spread alike over the older rocks from the lowest to the highest levels. The materials of the drift appear to be made up of the debris of the rocks existing *in situ*, immediately beneath or a short distance to the northeastward, together with a greater or less proportion derived from those lying further off in the same direction. As a rule, the softer or more clayey part has come from the underlying strata, while the harder pebbles and bowlders are the furthest transported; still, in washing out the finer ingredients, it is always found that much of the incorporated sand and gravel is of foreign origin. The nature of the transported bowlders and pebbles varies in different localities, but more than half of its bulk, on an average, consists of local material. On the first and second prairie steppes the most abundant constituent of the transported portion is Laurentian gneiss, while the remainder is made up of light-colored unfossiliferous limestones, supposed to be Silurian and Devonian, together with a proportion of Huronian schists, which varies in different localities. On the third steppe, however, smooth pebbles of finely granular quartzite predomi-

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* Geo. Sur. of Canada, for 1874–75.

nate. These are mostly white, but some are gray, brown, pink, and red, the latter often passing into banded compact sandstone. There are also pebbles of dark, fine-grained diorite, light-colored limestone, and some of dark fine-grained mica schist, and of white translucent quartz, the last mentioned being often rough surfaced. Mr. George M. Dawson thinks this quartzite drift has come eastward from the foot-hills of the Rocky Mountains, where in the neighborhood of the line (latitude 49°) he found unfossiliferous rocks *in situ,* some of which resemble certain varieties of these quartzite pebbles, but Rev. Pere Petitot collected white saccharine quartzite from the McKenzie river exactly like that of the white pebbles of the third steppe.

While the composition of the bowlder clay of the first and second prairie steppes, and also, to some extent, that of the third steppe, as well as the course of the striæ on the hard rocks on the east side of the prairies, would indicate that the drift had been mainly from the northeastward, the above evidence shows that a large proportion of the transported material on the highest levels has come from the north, or west. A part of what is now found in some localities may have been moved first in one direction and afterward in another, whilst the bulk of the older drift, including, perhaps, even that on the third steppe, has probably come from points between north and east. The quartzite pebbles of the third steppe are all thoroughly water-worn, and appear to be most abundant on and near the surface. The upper 200 feet, or thereabouts, of the south bank of the South Saskatchewan, at the Red Ochre Hills, consists of clayey drift, in which bowlders of Laurentian gneiss occur, while the surfaces of these hills are strewn with smooth quartzite gravel and cobblestones. At the distance of 150 miles to the southeastward, between the Dirt Hills and the Woody Mountain, the proportion of quartzite gravel on the third steppe has diminished considerably, and Laurentian bowlders have become very numerous on the surface.

Between Fort Garry and Fort Ellice, Huronian bowlders and pebbles are scarce, they are, however, abundant in the drift in the banks of the Assineboine for some miles above and below the junction of the Shell river, and in the banks of the Calling river in the neighborhood of the Fishing Lakes. They are noticeable on the surface all the way from these lakes to the Touchwood Hills. Surface bowlders are extremely abundant on the southern and western sides of the gravelly and sandy tract southwest of Fort Ellice, about the head waters of the Calling river, and in many places on the high ground of the third

steppe, between the Dirt Hills and the Woody Mountains. By far the greater number of the bowlders in all these localities consists of Laurentian gneiss, many of them are angular, although the majority are pretty well rounded. In each of the above districts, the bowlders are so numerous, over considerable areas, that a man might walk upon them in any direction without touching the ground.

In going from the northwest angle of the Lake of the Woods, toward Fort Garry, the road for long distances, runs upon low ridges of limestone-gravel between swamps, until reaching the drier ground between the White Mouth river and Oak Point, and in this interval, bowlders and pebbles of light-colored limestone are very common. They are also strewn abundantly on the shores around the southwestern part of Lake of the Woods. In the northern part of Lake of the Woods, and in the region of the Winnipeg and English rivers, limestone fragments are extremely rare, so that their sudden appearance, in such abundance, to the West and South of the northwest angle, would appear to indicate the occurrence of this rock *in situ* in the immediate neighborhood.

The magnetic bearings of the striæ in different parts of the country drained by the Winnipeg river, are as follows:

Around Wesaxino lake, S. 10° to 20°W.; two miles South of Sturgeon lake S. 40° W.; southeast shore of Sturgeon lake seven miles from southwestern extremity S. 20° W., and six and a half miles from southwestern extremity, S. 15° W.; North end of Hut lake, S. 25° W.; East end Kitchi-Sagi or Big-Inlet lake, S. 15° W.; inlet of Jarvis lake, S. 10° W.; Minnietakie Falls, S. 35° W.; island on Minnietaka lake, four miles southwest of Abram's chute, S. 45° W.; Abram's chute, at outlet of Minnietaka lake, S. 25° W.; Pelican falls, S. 45° W.; Stormy Point, on North side of Lonely lake, 24 miles from its outlet, S. 60° W.; Shanty Narrows on Lonely lake, 15 miles from outlet, West; outlet of Lonely lake, S. 75° W.; island in Maynard's lake, English river, S. 20° W.; narrows between Tide lake and Ball's lake, English river, S. 70° W.; outlet of Indian lake, English river, S. 30° W.; inlet of Lount's lake, English river, S. 40° W.; outlet of Lount's lake, S. 45° W.; entrance to South arm of Separation lake, English river, S. 50° W.; Winnipeg river, at entrance to Sandy bay, S. 45° W.; northwest shore of Lake of the Woods, seven miles from Rat Portage, S. 25° W.; Manitou Minis, 15 miles southwest of Rat Portage, S. 20° to 30° W.; Hone Point, 18 miles southwest of Rat Portage, S. 45° W.; Dead Oaks Point, 20 miles southwest of Rat Portage, S. 40° W.; and island in Lake of the Woods, 25 miles southeast of entrance to northwest angle, S. 25° W.

In the three prairie steppes there is a marked difference in the general aspect of the surface of the country, and in the character of the river valleys. On the first steppe, the surface is usually level, or undulating in long gentle sweeps, and the beds of the principal streams do not, probably, average more than 30 feet below the level of the surrounding country. On the second steppe the surface is rolling, and the river valleys are usually from 150 to 200 feet in depth, while on the third, the hills are on a larger scale, and either closely crowded together, or they rise here and there to considerable heights overlooking less rugged tracts. The principal river-valleys on this steppe are from 200 to 500 feet deep. The "coulees," as they are termed, form a curious feature of the third prairie steppe. These are valleys, or ravines, with steep sides, often one hundred feet or more in depth, which terminate or close in, rather abruptly, often at both ends, forming a long trough-like depression; or one of the extremities of the coulee may open into the valley of a regular water-course. The coulees sometimes run for miles, and are either quite dry or hold ponds of bitter water, which evaporate in the summer, and leave thin incrustations of snow-white alkaline salts.

The average depth of the river-valleys of the first and second prairie steppes is not affected by the general descent of the country through which they run. From the Little Boggy creek to the Arrow river, the Assineboine must fall 400 or 500 feet, yet the banks of the valley maintain the same general height and the same character throughout the whole distance. Similarly, the fall in the Calling river, from the Sand-Hills lake to its junction with the Assineboine, can not be far from 500 feet, and still its valley-banks have the same average height throughout. The fall in the Red river, from Moorehead to Fort Garry, is upward of 200 feet; but in the whole of the distance, the banks of the river have a nearly uniform height of 20 to 30 feet.

The great valleys of the third steppe cut entirely through the drift and far down into the underlying Tertiary and Cretaceous rocks; those of the second steppe appear to correspond, in a general way, with the depth of the drift, while on the lowest steppe, the streams have merely cut through the modified deposits resting upon the drift, which latter is occasionally exposed at low water at the foot of the banks, or in the bed of the stream at swift places and rapids. The stratified clay, silt, sand, and gravel of the Red river and the lower Assineboine, vary in thickness from almost nothing to 80 or 90 feet, and a variable thickness of bowlder clay is interposed between these deposits and the older

rocks, which lie beneath them all. At one place, in sinking a well, after passing through the surface deposits, blue clay was penetrated 70 feet in thickness, followed by 18 feet of sand, gravel, and clay, below which a light-colored limestone was reached. There is ample proof that the Winnipeg basin has been filled with water to the foot of the second prairie steppe, in recent geological times. In digging wells in the city of Winnipeg, wood bark and leaves are sometimes met with, and fresh-water shells occur in the sand deposits between the south end of Lake Manitoba and the Assineboine river, about 50 feet above the former. The level of Lake Winnipeg above the sea is 710 feet, St. Martin's lake 737 feet, Lake Manitoba 752 feet, Lake Winnipegosis and Cedar lake 770 feet, and Lake of the Woods 1,042 feet.

The drift striæ* in the eastern part of Wisconsin are exceedingly variable. Between the Kettle range and Lake Michigan, their course is from S. 4° W. to S. 116° W. Between the Kettle range and the Green Bay and Rock River valley, their course is from S. 12° W. to S. 59° E. In the trough of the Green Bay and Rock River valley, their course is from S. 41° W. to S. 7° E. And on the west slope of the Green Bay and Rock River valley, from S. 94° W. to S. 24° W. The diagram used to illustrate the course of these striæ, resembles the flowing vanes of an ostrich feather, with the shaft pointing to the northeast.

The drift deposits are separated in ascending order, into: 1st—Bowlder clay; 2d—Beach formation; 3d—Lower red clay; 4th—A beach formation; 5th—Upper red clay; 6th—Beach formations. The elevation of the beach ridge which marks the western limit of these deposits above Lake Michigan, near the Illinois line, is 55 feet; farther north, from 40 to 80 feet. North of Milwaukee there is a well-defined terrace, nearly parallel to the lake shore, from 50 to 100 feet high. In the vicinity of Sturgeon Bay, the terrace is replaced by a beach ridge of rather fine yellow sand. Along Green Bay, between Egg Harbor and the mouth of Sturgeon Bay, terraces of rock sustain a relation to the present shore similar to the terraces farther south. These rise, in some cases, almost vertically, to a height of more than 100 feet. The distance between them and the bay varies from a few rods to half a mile or more, and the interval is strewn with water-worn fragments of rock and occasional slight beach ridges.

In Central Wisconsin, the courses of the striæ are not less variable, though but few have been observed. In Dane county, they vary from

* Geo. of Wisconsin, vol. ii, 1877.

S. 35° E. to S. 81° W. In Columbia county, from W. to S. 85° W., and S. 47° W. In Sauk county, from S. 50° W. to S. 85° W.; and in Green Lake, S. 68° W.

In southwestern Wisconsin, there is a driftless region of more than 12,000 square miles, or about one-fourth the entire area of the State. Drift striæ and drift materials are absolutely wanting. The topography of the country shows that it was never invaded by the drift. Except in the level country of Adams, Juneau, and eastern Jackson counties, it is everywhere a region of narrow, ramifying valleys, and narrow, steep-sided, dividing ridges, whose directions are toward every point of the compass, and whose perfectly coinciding horizontal strata prove conclusively their subærial erosion. The ravines are all in direct proportion to the relative sizes of the streams in them.

The altitude of the country seems to have performed no part in the causes which kept the drift from this extensive tract of country, for north of the head of sugar river, the limit crosses high ground, and the altitudes east of the limit are as great as those to the west; Sauk prairie is crossed on a level. Where the quartzite range north of Sauk prairie is crossed by the limit, it is higher (850 feet above Lake Michigan), than any part of the driftless area, except the Blue Mounds, whilst east a few miles, drift is found at 900 feet in altitude. From the limit near the east line of Adams county, the country, for 40 miles to the west, is from 100 to 200 feet lower. From the northwest part of Adams county, to the Wisconsin river, the limit is in a level country; whilst from the Wisconsin westward the country north of it is everywhere much higher than that to the south, the rise northward continuing to within 30 miles of Lake Superior. It thus appears that the driftless area is in a large part lower than the surrounding drift-covered country. Moreover, there is a scantiness of the drift from 25 to 75 miles north of the driftless area.

Roland D. Irving* said, the lacustrine clays extend inland from Lakes Michigan and Superior for many miles, and reach elevations of several hundred feet above the lakes. They are stratified beds of loose material, chiefly marly clays, with more or less sand, some gravel, and a few bowlders. They were deposited, evidently, when the lakes were greatly expanded beyond their present limits. In the Central Wisconsin district, the lacustrine clays have only a small development, most of the district being either too high to have been reached by the lake depositions, or else lying behind the dividing ridges. The eastern

* Geo. of Wisconsin, vol. ii.

towns of Waushara county, however, are underlaid by a considerable thickness of red clay belonging to this formation. The surface elevation of the country here is 160 to 200 feet above Lake Michigan, and the clays 80 to 100 feet and over in depth, as shown by numerous artesian well borings that yield a flow of water which is obtained from seams of gravel at different horizons in the clay. The clay of eastern Waushara county is part of a large clay area that extends up the Green Bay valley from Lake Michigan, and it is quite significant, that Prof. Irving's map of this lake deposit shows that it extends within about twenty miles of the northeastern part of the driftless area of Wisconsin.

Afterward* he said the lacustrine clays underlie all of the lower levels bordering Lake Superior, above which they rise to altitudes of between 500 and 600 feet. This carries them well up the front slope of the Copper range, and high, also, on the flanks of the Bayfield highland. On the Wisconsin Central, these clays reach to an altitude of 560 feet, and are finally left, on ascending the railroad line from Lake Superior, near where Bad river is first struck.

The clay varies largely in amount of sandy admixture. There is commonly some sand included, though, at times, it seems almost wholly absent, and at others to make up the bulk of the formation. The clayey matter is always of a red color, and always contains a considerable proportion of lime carbonate. The stratification is not always evident, but on the shore bluffs of the Apostle islands, it may be seen in the darker color of the moist sandy layers as compared with the lighter sun-dried clay. In many places, numerous small bowlders, chiefly of some dark greenstone-like rock, are to be seen embedded in the clay, and pebbles of the same, and other crystalline rocks are abundant. On the shores of some of the Apostle islands, and in places along the mainland coast, dark-colored bowlders of large size, presumably washed out from the clay, are very abundant. The entire thickness of these clays can not be less than from 400 to 600 feet, about 100 feet being the greatest thickness seen in any one section.

Mr. E. T. Sweet found a section of the lacustrine sands and clays, with gravel and bowlders, on the north bank of the St. Louis river, about one-quarter of a mile from Greeley station, 202 feet in thickness. In the vicinity of Fon du Lac, and southeast of Superior City, along the old St. Paul military road, he found lake terraces at 15, 35, 80 and 120 feet above the present level of the lake, and an indistinct one at the

* Geo. of Wisconsin, vol. iii.

height of 300 feet. Along the Brule river, in the vicinity of the mouth of the Nebagamain, where the river is 300 feet above Lake Superior river terraces are found 30, 80, and 190 feet above the river. From the top of the highest terrace, or level of the surrounding country, to the corresponding top on the opposite side of the valley, the distance is about a mile.

The lake terraces and lake deposits of sand and clay at these heights in Wisconsin, show that Lake Superior has stood at a height sufficient to have overflowed the highest lands in any of the States south of it. The driftless region in the western half of the State, is alike conclusive against any of the drift phenomena in the eastern part, having been the result of glacial action of any kind, and they both unite in testifying against a continental ice sheet, or glacial period.

In Dakota county, Minnesota, there occurs an outlier of the St. Peter's sandstone, known as "Lone Rock," owing to its standing in a prairie, and forming a conspicuous object for many miles in all directions. Its summit is about one hundred feet higher than the surrounding country, and from this point a number of outliers and pinnacled rocks of the same sandstone may be seen. One of these is called "Chimney Rock," from its fancied resemblance to a chimney; and another, standing seventy feet high above the surrounding country, is known as "Castle Rock," the upper twenty feet of which is now so slender that but few centuries will pass before it totters and falls, under the wearing effects of subærial denudation. These sandstone outliers are monuments attesting the erosion which has taken place since Silurian times, and yet, in the valleys of this county, the drift prevails and bowlders abound. In Wabasha county, we have the "Twin Mounds," and in Olmstead county, the "Sugar Loaf Mound" and the "Lone Mound," and numerous isolated bluffs, attesting the erosion for the same period. In Fillmore county, the Trenton Group forms precipitous bluffs. It rises perpendicularly from the short talus at the base, which adjoins the creek, forming canons, which widen as we descend the streams, and which, like the monuments of other counties, attest the erosion through long periods of time. The weathering and erosion have left many scenes in the bluffs of wild and picturesque beauty, as at Weisbeck's dam, in Spring valley, that, standing alone, or considered in their relations to each other, as their bearing is found in all directions of the compass, are convincing proofs of the non-existence of the glacial epoch. But the strongest proof, it seems, that one could wish against the glacial speculation, may be seen in two lonely towers,

in the valley of the south branch of Root river, in this county, known as the "Eagle Rocks." The valley is one of denudation, by the ordinary subærial forces, and it has been excavated out of the Trenton Group; and yet, two lone towers, rising as high as the rocky walls of the valley, are standing to say that no glacial sheet ever moved in this valley.

Indeed, no one having any knowledge of geology, has found any evidence of glacial action in the Mississippi valley, or in the streams that flow into it from Minnesota; but, on the contrary, every geological fact bearing upon the subject is so strongly against it, that we unhesitatingly conclude that no glacier, great or small, ever entered it; and as to the hypothetical continental glacial sheet in this valley, it certainly suggests physical impossibilities. The valley of the Mississippi is one of erosion. At Minisca, the hills are 525 feet high. The slopes are such as are made by ordinary forces, without the intervention of anything extraordinary. The harder layers of rock stand out in bold cliffs on the sides of the valley, while the softer layers form slopes between the harder layers, marking the disintegration and denudation as it takes place under atmospheric influences. Streams enter the valley at right angles, and these are fed by streams flowing into them from the north and from the south in valleys of corresponding depth, and protected by sides of similar slopes and cliffs, and even more rugged bluffs; for, as we recede westerly from the Mississippi river in Southern Minnesota, higher rocks come into view, until the valleys are excavated in the limestones of the Trenton Group, instead of the softer magnesian limestones that abut upon the Mississippi valley. If a sheet of ice were to fill these valleys above the top of the dividing ridges, we may fairly conclude that it would be held so firmly that it could move in no direction; but if it could move either north or south, or east or west, the sharp escarpments of magnesian limestone, the rugged bluffs of the Trenton limestone, the bold outliers in the widened valleys, and the pinnacled towers on the level prairies forming the divides between the streams, would be ground down, smoothed off, or entirely torn away.

A trip up the Mississippi river, from Dubuque, Iowa, to St. Paul, Minnesota, or across the country at La Crosse, Minisca, or Lake Pepin, will bring to the view of the observer the incontestible evidences against the existence of a continental glacier, in times so recent as the Pliocene or Post-pliocene. In the absence of the opportunity of taking the trip, turn to Owen's Geological Survey

of Wisconsin, Iowa, and Minnesota, and look at the "Natural Section of Hills, Upper Mississippi;" "Cliff of Lower Magnesian Limestone, Plum Creek;" "Alterations of Magnesian Limestone and Sandstone, Kickapoo;" "Lagrange Mountain;" "Castellated appearance of Lower Magnesian Limestone, Upper Iowa;" "Lower Magnesian Limestone, Upper Iowa;" "Cliffs of Lower Magnesian Limestone, Upper Iowa River;" "Outlier of Sandstone, Kinnikinick;" "Outcrop of Upper Magnesian Limestone and Shell Beds, Turkey River," and you will be enabled to form some idea of the bluffs, cliffs, castellated rocks, and pinnacled outliers, that are so utterly inconsistent with the glacial hypothesis.

Such scenes are also presented in the State of Wisconsin, both within what is universally conceded to be the driftless area and without it. Two of these curious isolated eminences are situated in Dark Hollow, north of Wingville, on the head waters of the Blue river, near the junction of Badger Hollow, and composed of the Upper Sandstone, as illustrated in Hall's Geological Survey. Another called the "Stand Rock," in the Dells of the Wisconsin, forms the frontispiece to Vol. ii. of Chamberlin's Survey. But Prof. R. D. Irving informs us that a remarkable feature of all of the palæozoic portion of central Wisconsin, is the occurrence of *isolated ridges and peaks*, rising from 100 to 300 feet abruptly, and often precipitously from the low ground around them, and composed of horizontally stratified sandstone, or of sandstone capped with limestone. Such outlying bluffs lie all along the face of the high limestone country of Columbia and Dane counties, and are, generally, there capped by the same limestone that forms the elevated land, of which they are themselves fragments, others, again, and these are nearly all entirely of sandstone, occur scattered widely over the central plain of Adams and Juneau counties, often covering but a small area, and showing bare rocks from the base to the summit, which not infrequently are worn into jagged pinnacles and towers. He says the driftless area occupies 12,000 square miles (but the map indicates about 13,000 square miles) of the southwestern part of Wisconsin, or nearly one fourth the entire area of the State and that over this area the drift is not merely insignificant, but absolutely wanting. The line of separation of the driftless from the drift area, is thus traced:

Entering the State from the south, on the southern line of Greene county, the drift limit traverses this county centrally from south to north, and continues northward through western Dane and central Sauk; then curving eastward across the southern end of Adams, it

follows along the eastern line of that county, passes into Portage, curves westward, and crossing the Wisconsin river again, continues in a nearly westward direction across Wood, Clark, Jackson, Trempealeau, and Buffalo counties, to about the foot of Lake Pepin, on the Mississippi.

He says, that east of this limit, the fragile castellated outliers that abound in the driftless area are wanting, though outliers do occur, though not abundantly, and they are thick and of rounded contour, and more commonly of limestone; but that north of this line the drift is quite insignificant, and all surface irregularities are as purely the result of subærial agencies as in the driftless region itself. And this corresponds with the outliers in Dakota county, Minnesota, mentioned above, which are north of Lake Pepin, and within the drift area.

There are several grand outliers in Jackson county, Illinois; one of these is called the "Back-bone," and another the "Bake-oven." The uplands contain some drift and gravel, but none have been observed south of the dividing ridge that crosses the State through the south part of this county and the north part of Union. The drift clays and gravel do not average more than 20 feet in thickness, and below these there is frequently found a dark blue or black mud, containing branches of trees, and sometimes trees of large size. In Perry county, the drift deposits seldom attain a thickness of more than 30 or 40 feet. But below them, as in Jackson county, there is a layer of blue mud lying on the stratified rocks, which is so full of partly decomposed vegetable matter, consisting of leaves and wood, as to render the water in wells that penetrate it, unfit for use. In Jersey county, the drift consists of about 20 feet of yellowish-brown clay at the top, below which there occurs from 20 to 30 feet of sand and gravel, with bowlders; and this is underlaid by about 15 feet of blue plastic clay, which contains fragments of wood, and even trees of considerable size. In Greene, Calhoun, and Scott counties, there is some evidence of buried channels where the drift is 100 feet or more in thickness. In Cook county, there is abundant evidence of the lake having been 40 feet higher than it is now, and that trees grew upon the surface, at levels lower than the present height of the lake. There is also some evidence here of a buried river channel. In Adams county, below 90 feet of drift clay, with gravel and bowlders, there occur an ancient soil and subordinate clays, without bowlders, or other evidences of drift action. At Sycamore, in DeKalb county, large pieces of wood were met with in the blue clays, at the base of the drift, at 50 feet in depth; and similar

instances occur in Kane, Dupage, Richland, Monroe, Morgan, Tazewell, and other counties. Indeed, in nearly every portion of the State, remains of trees are found in the ancient soil in which they grew *in situ* beneath the gravelly clays and hard pan of the drift.

In Martin county, Indiana, near the town of Shoals, on the O. & M. railroad, there are numerous outliers of sandstone of carboniferous age, high and sharp ridges, and much wild and rugged scenery. A high ridge terminates near the east fork of White river, from the top of which there is a projecting mass of conglomerate sandstone, called the "Pinnacle," which stands 170 feet above the level of the stream. On the north side of this ridge, there is a tall outlier, which is called "Jug Rock," from the resemblance which it bears to a jug. It is 42 feet high, and supports, on its top, a flat projecting layer, which is called the "Stopper." A picture of this rock forms the frontispiece to the Second Report on the Geological Survey of that State, by E. T. Cox. The "Knobs," or "Knob stone formation," of Southern Indiana, is so named from outliers of subcarboniferous sandstone that have protected the underlying shaly rocks from denudation during all the ages that have passed since the Carboniferous era. Warren county is situated in the northwestern part of the State, and is deeply covered by the drift, near the base of which, and resting on a broken and irregular floor of Coal Measure rocks, there is generally found a bed of clay somewhat intermixed with quicksand and black muck. In sinking a shaft to the base of this drift, an ancient soil, containing the roots of trees and shrubs *in situ* was discovered, notwithstanding the passage through more than 50 feet of the bowlder drift and clay. And it may be laid down as a rule, in Indiana, that in all cases where the soil was not swept off by the flood of waters in the drift period, it will be found, at the base of the drift, containing the evidences of land vegetation, not materially distinct from that which now prevails on the top of the drift deposits.

There are extensive driftless areas in eastern and southern Ohio. These are marked by outliers, monument rocks, sharp ridges, rugged scenery, and the total absence of the drift sand, gravel, and bowlders, that characterize drift areas. The outspread of the drift materials from the north extends to the sources of the rivers that flow into the Ohio, and over more or less of the land intervening between the minor branches, near where the leading streams arise; but below this, the drift material is found only in the valleys of the principal rivers. It seems that wherever the valley was large enough to carry off the flow

of water from the north, the adjacent land was not overflowed, and the height of the water in the valley was marked by river terraces. In eastern Ohio, however, only those rivers which have their sources in the central and northern part of the State, have river terraces, as the Scioto, Hocking, and Muskingum rivers; while the smaller tributaries of the Ohio, such as Raccoon, Shade, Little Muskingum, and Duck creek, have not a vestige of the evidences of the drift from their sources to the Ohio. Some counties are absolutely driftless areas, while others, like Athens and Washington, show that the water passed down the Hocking and Muskingum valleys, but overspread no other part of the country. The same phenomena may be observed in Indiana and Illinois. The water did not cross the great valley of the Ohio until it reached the western part of Kentucky, for the States of Kentucky and Virginia, south and east of the State of Ohio, are absolutely driftless areas.

It is an important fact, that throughout the drift area of Ohio, in all well authenticated cases of excavation, below the drift, where there are no evidences of denudation, at the particular places, there has been found an ancient soil of vegetable mould resting upon the disintegrated stratified rocks in place. The beech, sycamore, hickory and cedar have been found where they grew prior to the existence of the drift period. And beneath this ancient soil, no one has discovered striated or furrowed rocks, such as the glacialists have claimed as an evidence of their theory, and which are not uncommon where the ancient soil does not exist. Wherever a ridge is found having an easterly and westerly direction, the north side and the plains to the north are covered with this ancient soil, reposing on the stratified rocks, beneath the whole mass of the drift. But on the ridges the soil is usually absent, and the rocks are not unfrequently scratched and covered with drift resting upon the abraded surfaces.

A very good illustration of the ancient soil beneath the drift may be seen at the railroad cut north of the tunnel on East Walnut Hills, in the city of Cincinnati. This soil has a thickness in one place of four feet, and consists of a compact mass of very dark, rich, decayed vegetable matter full of roots which are lignitiferous, and still retain the hard woody fibers in a moderately good state of preservation. It reposes on the rocks of the Hudson River Group, and is covered by the sand and gravel of the drift, twenty feet or more in thickness.

The excavation exposed it upon each side, for a distance of about 100 feet, but the masonry will entirely cover it and hide it from view this season.

Commencing in the lower tier of counties in the State of New York where the hills are from 600 to 800 feet above the level of the narrow valleys, as they occur in Cattaraugus, Alleghany, Steuben and Chemung counties, and extending South over all the highlands of Pennsylvania, and over Virginia, West Virginia, the Carolinas, and the eastern parts of Kentucky and Tennessee, and South to the Gulf of Mexico, we have an absolutely driftless area; an area of dry land when the marine clays and sands were strewn over the territory adjacent to the Gulf of St. Lawrence, and over the New England States; and also an area of dry land during the period of the drift, of the central part of the continent, and for untold geological ages antecedent thereto. The elevated hills, precipitous ledges, profound valleys, overhanging rocks, and castellated outliers of the Carboniferous conglomerate in Cattaraugus county, some of which are illustrated in the Geology of McKean county, in the Report of Progress R. of the Second Geological Survey of Pennsylvania, under the name of the Olean conglomerate at Rock City, furnish the most incontestible evidence of the ordinary eroding agents through a period of time, commencing long anterior to the Tertiary epoch, and equally as conclusive evidence that no glacier ever passed over that territory.

During the ages that elapsed from the Carboniferous to the Tertiary, the Ohio river and its tributaries were excavating their valleys, and so also were the streams that flowed through the channel, that drained the northern and central part of the continent, which is now represented by the chain of great lakes. Where the valleys thus eroded remain unaffected by the drift, they are frequently immense chasms. The streams which flowed from the divide into the great drainage system of the north, cut out the valleys precisely as did the tributaries flowing south or east into the Ohio, and to equally as great depth. Could we see northern Ohio stripped of the drift, we would see a country quite as rough and rugged as southeastern Ohio. But there came a time when this drainage system of the north was obstructed in the region of Lake Ontario, and the waters were thrown back over the country, forming an immense lake. From this lake, deposits of clay, sand and gravel were precipitated over the country overflowed, and from the northern shore or sides of the Laurentian mountains, the shore ice transported to the south bowlders and rocky masses, in the same manner that it transports them now from one side of Lake Winnipeg to the other, and thus, much of the country was changed from its broken and hilly aspect into nearly a level plain. And when this lake over-

flowed the barrier or dividing ridge on the south, and swept over Ohio, Indiana, Illinois, western Kentucky, Tennessee and Mississippi, it transported the material that constitutes the drift deposits of these States, and which extends in the Mississippi valley as far as the Gulf of Mexico. The rush of water was adequate to transport and distribute the finer material, and the shore ice was sufficient to transport the bowlders and larger masses, and distribute them as far south as they occur.

The lake deposits on the hills and mountains near the shores of Lake Superior, occur 600 feet above the present level of the lake, or high enough to overflow all the States to the south. The ancient soil beneath the drift affords evidence that the climate was not materially different from the climate of to-day. The land and fresh-water shells found at different elevations in the drift, and the oft recurring timber transported and buried at all heights within it, show nothing that indicates a change of climate from the time preceding the drift through all its various stages. The ancient beaches prove the different elevations of the lakes, and teach us of long periods of time required for the pebbles and bowlders to be made, that now form these terraces, where they are preserved, and constitute so considerable a part of the drift that was swept southwardly when the lakes overflowed their barriers and carried them away.

The drift is then not only of Post-pliocene age, but much of it dates back through all Tertiary time, and some of it is, probably, much older. But that part of it containing the Mammoth, Mastodon, Dicotyles, Castoroides, and other mammals, with aboriginal man, belongs to the most recent or Post-pliocene era.

The eastern end of Lake Ontario is near a volcanic region, and within the range of the Appalachian system, where there have been important local elevations and depressions, as heretofore shown, by the sinking and rising of the coast from New York to Hudson's bay. The disturbance and elevation has been sufficient to throw the lakes back over the State of New York, and high up on the hills to the north, as shown by the numerous terraces, beaches and lacustrine deposits. This great lake may never have united with the grand body of water which is now represented on a smaller scale by Lake Superior, and again they may have been united at some period, and disunited at others. But all the phenomena presented in this region is to be accounted for by the presence of these lakes at various altitudes.

Lake Superior is in a volcanic region, and near the western end of

the Laurentian mountains, and it is not improbable that earthquakes and volcanic energies had something to do with the emptying of these vast bodies of water over the country to the south. The drift deposits, to the west of Lake Superior, which spread over part of Minnesota, and extend as far south as the Missouri river, belong to an overflow of the great central lake of British America, which is evidenced by the terraces and beaches of that extensive region. The overflows have, therefore, not only occurred at different periods of time, but, probably, from three different bodies of water. If then, all the phenomena are to be accounted for by ordinary and well known forces of nature, why call to their aid a glacial period, which will account for none of them.

Taking a broad and general view, we would say that the drift upon the eastern part of the continent, from the mouth of the Hudson river to Hudson bay, is marine, and the striæ upon the rocks were produced under water. The age dates back to the Pliocene era, and probably to the Miocene. When this margin was depressed, a corresponding elevation took place east of Lake Ontario, that blocked up the great river that had drained the central part of the continent, as far west as Lake Superior, during the Triassic, Jurassic, Cretaceous and earlier Tertiary periods. This elevation was more than 500 feet, as proven by the lacustrine clays exceeding that height, which were formed upon the hill and mountain ranges surrounding the great internal lake caused by this back-water, and as further evidenced by the fact, that after the lake had been permitted to stand at this height for so long a period as to form terraces and beaches, that later, it excavated the elevated barrier to a depth of 500 feet, forming a channel, which is now in the bed of Lake Ontario, and when the eastern coast was again elevated, this region was correspondingly depressed.

The drift on other parts of the continent is fresh water or lake drift, and the striae were produced, except in cases of drifting sand under atmospheric influences, by the action of water forcing harder materials against obstructions, or over barriers, and by floating shore ice having frozen within it, the sand, gravel and bowlders of the place in which it was formed. In the Rocky mountain region, each valley is the limit of its own drift phenomena; but when the northern part of the range was elevated, a very large interior lake was formed in British America, which seems to have covered many valleys, and in times comparatively recent, to have overflowed the country so as to empty itself in part, into the streams that flow south into the Missouri and Mississippi rivers.

Another great overflow took place from the more central lake. This

extended over the eastern part of the State of Illinois, over Indiana and the western part of Ohio. The overflow had a width of more than 300 miles, and from its western margin it followed the streams westerly to the Mississippi, and from its eastern margin to the Ohio, so that its greatest width in these States exceeded 500 miles. This overflow may have been produced by volcanic energies in the Lake Superior region, and occurred as late as the Post-pliocene age. It was the great destroyer of the mammoth and the mastodon and other extinct Post-pliocene mammalia. Since that period the lakes have gradually drained themselves to lower levels through the outlet at Lake Ontario, leaving here and there lower lake beaches and terraces. In process of time, Niagara Falls will recede to Lake Erie, and that lake will be drained to its ancient channel, and other beaches and terraces will be left to represent the present height of the lake in the same manner that I have supposed the higher beaches and terraces to represent the former levels. This explanation seems to the author sufficient to account for all the phenomena discovered by the geologists, and it certainly calls to its aid no mythical hypothesis or unknown freaks of nature, but rests upon well-known physical and geological laws.

It is no small tax upon the imagination to believe that a great sheet of ice, having an existence in the north, ascended the Laurentian mountains north of these lakes, and then dipped down into the earth, scooping out Lake Superior 900 feet in depth, pulverizing the material, transforming it into gravel, sand and bowlders, scraping off the soil in some places, and scratching the rocks in others, as it ascended the valleys to the height of the dividing ridge between the waters that flowed to the north and the south, and precipitating itself into the tributaries of the Ohio, Mississippi and Missouri rivers, and depositing behind it in such even and beautiful distribution the sand and gravel that now fills the ancient valleys, and forms a vast, almost level plain over the northern parts of Ohio, Indiana and Illinois, and yet did not sweep off the ancient gravel beaches, in many places, that now mark upon the mountains and hills the ancient shores of vast bodies of water.

To believe in the glacial theory requires all this stretch of the imagination, and to be a real sound stalwart in the faith, there are many other marvelous things which must be accepted. One of these is described by a Pennsylvania geologist, to account for the drift phenomena of New York. He says :

"But when the ice front had been melted back to the southerly crest

of the Chautauqua divide, the battle between the elements of heat and cold commenced in earnest. North of the barrier, the ice-king had massed his forces; Lake Erie basin was full of ice, and all the reserves of the north were freely moving down into it. As fast as one skirmish line on the summit was repulsed, another was thrown forward; and thus alternately advancing and retreating, the contest raged for ages before the invading ice was forced back, permanently confined, within the limits of the present lake basin."

The Muse that divulged this information must have been slain in the last glacial engagement, and remained for ages housed up in her little sepulchre, because, otherwise, it is evident that she would have told all about the grand glacial ball which ensued after the victory was complete, when the glaciers danced quadrilles, waltzed and mazourkied, and scratched and furrowed the rocks in all directions, followed by cutting the "pigeonwing" and the great American "hoe-down," when the glaciers shook the gravel, sand and bowlders, which they had collected for war, out of their crests and huge depositories, and covered the earth, which in their great glee they had cut up and striated so beautifully.

In conclusion, the author would seriously call the attention of the reader to the array of facts here collected tending to prove that there is no marine or other deposit which represents a glacial period of time, and, therefore, there is no such geological period; that there is no gap in geological nomenclature into which it can be lodged or injected. That the fossils and animal and vegetable remains teach us of no such period, but quite the contrary. And, finally, that the glacial epoch is a theoretical blunder, without the support of any known facts, and averse to all our geological and palæontological information.

THE CENTURY PLANT.

By Joseph F. James.

An interesting plant was on exhibition lately (July, 1881) at the Highland House. This was the *Agave americana*, the American aloe or the Century Plant, so called from the popular but erroneous idea that it blossoms only once in one hundred years. It belongs to the natural order Amaryllidaceæ, which is closely allied to the Liliaceæ. It is a native of Southern United States, Mexico and South America.

It is nearly stemless, and the large, thick, spiny leaves spring almost directly from the apex of the root. The leaves are sometimes six feet in length, and they make the plant an excellent one for hedges, so that it is useful as well as ornamental. The root is very small in comparison to the size of the leaves, for the latter furnish much of the material necessary for the growth of the plant.

In its native country, the *Agave* often flowers when from ten to fifteen years old, and even in England has been known to do so at fifty years. As soon as the plant is ready to blossom, the flower stalk shoots up very rapidly. An account of a plant blooming in England, in 1737, says: "This plant opened the crown for flowering on June 5th; the stem bud appeared on the 15th, and grew five inches a day for some weeks; the flower buds were perfected in twelve weeks, and then it stood for a month while the buds were forming; the number of flowers was about 1,050."* Thus we see that an immense amount of material is stored up in the leaves, and as this is exhausted very rapidly, it is no wonder that when the plant has finished blooming, and has perfected its seed, that it is exhausted, and invariably dies. These flower stalks often attain a height of from twenty-five to forty feet, and bear from 1,000 to 4,000 blossoms. It branches in a candelabrum-like form, the blossoms on the lowest branches opening and perfecting first, and those above following in turn.

The flowers are of a greenish yellow color, growing in large bunches as big as a half bushel measure. The perianth is six parted. The filaments at first are curved over, and the anthers, swung nearly in the centre, are bent down and packed in the perianth. As the flower matures, the filaments straighten and elevate the anthers, while as soon as the pollen is shed, the stigma, which, until then, was almost concealed in the perianth tube, rapidly elongates and is soon ready to be fertilized. Thus, this is one of those plants whose flowers can not be fertilized by their own pollen, for when the stigma of a particular blossom is ripe, the pollen of that flower is gone. In this way close interbreeding is prevented, and cross fertilization becomes necessary for the perfection of seed.

The economical uses of the plant are many. Lindley says the root is diuretic and anti-syphilitic; as a cordage it is extremely tough, but the leaves have many more uses. When the expressed juice of the leaves is evaporated, the residue is said to be useful as a soap. The whole leaves

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* Treasury of Botany, vol. i., p. 30.

are used by the poorer classes of South America instead of writing paper, and also for thatching their houses. If the inner leaves of the plant are cut out just before the flower scape bursts forth, the sap flows abundantly. This has an agreeable sour taste, but soon ferments, is called "pulque," and has the odor of putrid meat. Europeans who have overcome their repugnance to the odor are said to prefer "pulque" to any other beverage. From it is made the fiery brandy known as "aguardiente," which has been a considerable source of revenue to the Mexican government. From three cities it collected a net sum of £166,497, equal to about $832,485.

The fibre of the leaves is made into cordage which is exceedingly strong. Humboldt describes a bridge with a span of 130 feet over the Chimbo, in Quito, of which the main ropes, four inches in diameter, were made of Agave fibre.* Orton says: "the flowers make excellent pickles; the flower stalk is used for building; the pith of the stem is used by barbers for sharpening razors; the fibres of the leaves are woven into sandals and socks; and the sharp spines are used for needles."†

It has been supposed by some writers that the Century Plant was the one which was referred to by old Chinese historians, in accounts given of a visit in the fifth century to the land of "fusung," supposed to be Mexico. Other writers have denied that the land of "fusung" was Mexico, and contend that it was Japan, because the poetical name of Japan was "fusung." Still, the account says that the country visited lay "twenty thousand *li*" to the east of China; and as a *li* is equal to one third of a mile, it is necessary to suppose Japan and China to be separated by over 6,000 miles, a rather improbable supposition. There is nothing very improbable in supposing that the Chinese crossed over to America by way of the Aleutian Islands, and they may have penetrated as far south as Mexico. The subject is fully discussed in the fifth volume of Bancroft's "Native Races of the Pacific Coast," to which I would refer any one who wishes to investigate the subject further.

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* Treasury of Botany, vol. i., p. 30.

† Andes and Amazon, p. 101. "Terzozomoc, the high priest of the ancient Mexicans, gave aloe leaves, inscribed with sacred characters, to persons who had to journey among the volcanoes, to protect them from injury. *Ibid.* p. 100.

THE MADISONVILLE PRE-HISTORIC CEMETERY: ANTHROPOLOGICAL NOTES.

By F. W. Langdon, M.D.

In the three previous papers relating to the above-mentioned cemetery which have appeared in this Journal,* attention has been directed chiefly to the status of the pre-historic inhabitants of this region, as manifested by their works and appliances; it is proposed, however, in this, the fourth paper of the series, to present some facts relative to peculiarities of the people themselves.

With this object in view, a table of cranial measurements is herein given, together with notices of such other osteological features as may be of ethnical, anatomical or surgical interest.

The table of measurements has been prepared by Dr. C. L. Metz and the writer, conjointly, with occasional assistance from Mr. Charles F. Low; acknowledgments are due both these gentlemen for their hearty co-operation in other respects. The writer also desires to express his sense of indebtedness to Professors F. W. Putnam and Lucien Carr, of the Peabody Museum of American Archæology and Ethnology, for various publications and suggestions which have been of value in the preparation of the present paper.

The internal capacities of the crania have been determined by means of dried peas, after the method pursued by craniologists generally, and are given in cubic centimetres; other measurements are in millimetres. The indices of breadth and height are in decimals, being the proportions borne by these dimensions to the long diameter.

No attempt has been made to estimate the brain weight; the capacities recorded, therefore, represent simply so much cubic space.

The sex has been determined, so far as practicable, from the general skeletal development and the shape of the pelvis; it is hardly necessary to add that due allowance should be made here for possible errors.

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* Vol. iii., 1880, pp. 40-68; pp. 128-139; pp. 203-220.

Table of Measurements of 83 Crania from Madisonville.

Number.	Capacity.	Length.	Breadth.	Height.	Index of Breadth.	Index of Height.	Width of Frontal.	Zygomatic Diameter.	Height of Orbit.	Width of Orbit.	Sex.
	48*	78*	77*	61*	72*	58*	69*	47*	60*	60*	
1	1420	178	144	138	.808	.775	96	144	33	37	M.
2	1190	170	133	130	.782	.764	92	.....	33	37	F.
3	....	176	150	....	.852	.....	.....	.....	.....	.....	M.
4	1660	182	153	139	.840	.763	90	144	35	38	M.
5	1110	170	134	132	.788	.776	94	136	37	37	F.
6	1330	176	138	133	.784	.755	92	130	38	39	F.
7	1300	159	143	138	.899	.867	.....	.....	37	41	M.
8	1350	163	141	130	.865	.797	84	.....	.....	.....	M.
9	1450	176	139	137	.789	.778	95	138	36	40	M.
10	1210	162	143	137	.882	.846	.....	.....	34	41	F.
11	1210	166	135	137	.813	.825	92	128	35	37	F.
12	1110	161	131	129	.814	.801	86	121	31	40	F.
13	1320	162	137	135	.845	.833	93	137	34	41	M.
14	1490	174	134	142	.770	.816	97	.....	33	41	M.
15	.....	161	138	...	.857	.....	97	136	35	40	M.
16	.....	163	142	139	.871	.852	107	157	35	46	M.
17	.....	168	.....	.....	.....	.....	95	.....	33	42	M.
18	.....	162	150	134	.925	.827	91	.....	34	40	M.
19	1440	170	136	133	.800	.782	91	135	34	41	M.
20	1450	177	134	138	.757	.779	.....	135	34	41	M.
21	1260	166	135	131	.813	.789	93	....	.....	.....	M.
22	1500	170	148	137	.870	.805	93	134	38	40	M.
23	1480	187	133	129	.711	.689	101	135	37	41	M.
24	1290	171	140	132	.818	.771	90	139	35	42	M.
25	1200	160	141	127	.881	.793	84	.....	.....	.....	F.
26	1340	178	137	137	.769	.769	93	143	36	40	M.
27	.....	163	142	140	.871	.858	101	.....	.....	.....	.....
28	.....	185	.....	.....	.....	.....	98	.....	.....	.....	.....
29	.....	161	128	.....	.795	.....	93	.....	31	40	.....
30	.....	162	135	.....	.845	.....	97	.....	...	.....	.....
31	.....	173	.....	.....	.....	.....	.....	.....	.....	.....	.....
32	.....	156	146	125	.935	.801	94	.....	38	40	.....
33	.....	162	.....	124	.....	.765	.....	.....	.....	.....	.....
34	.....	155	135	.....	.870	.....	96	.....	..	.....	.....
35	.....	164	140	.....	.853	.....	.....	..	38	41	F.
36	.....	175	.....	.....	.....	.....	97	139	35	40	M.
37	.....	....	158	.....	.....	.....	89	.....	38	40	.....
38	.....	157	139	.....	.885	.....	95	138	32	38	F.
39	....	179	149	....	.832	.....	94	138	33	40	M.
40	1360	169	142	137	.840	.811	....	.....	..	.....	F.
41	1150	167	137	131	.820	.784	87	130	30	39	M.
42	1370	176	140	138	.795	.784	95	138	35	39	M.
43	1490	169	150	143	.888	.846	96	140	34	41	M.
44	1380	166	136	138	.819	.831	89	140	35	40	M.

Table of Measurements of 83 Crania from Madisonville—Continued.

Number.	Capacity.	Length.	Breadth.	Height.	Index of Breadth.	Index of Height.	Width of Frontal.	Zygomatic Diam.	Height of Orbit.	Width of Orbit.	Sex.
45	1150	151	131	135	.868	.894	92	135	34	42	F.
46	1270	160	144	133	.900	.831	90	134	34	40	M.
47	1130	162	133	130	.821	.802	87	124	32	37	F.
48	1250	172	136	127	.791	.738	.....	.....	.....	.....	F.
49	.....	187	.....	.....	.....	.....	97	.....	.....	.....	M.
50	.....	164	140	.....	.854	.....	90	.....	.....	.....	M.
51	1290	175	133	130	.760	.743	91	132	36	41	F.
52	1160	162	136	126	.840	.778	96	133	36	38	F.
53	1250	164	133	129	.811	.787	96	131	34	38	F.
54	1300	171	138	139	.807	.813	97	135	34	43	M.
55	.....	.....	136	135	.....	.....	.....	140	36	40	M.
56	.....	180	131	135	.728	.750	98	.....	.....	.....	.....
57	.....	170	142	142	.835	.835	.....	.....	.....	.....	.....
58	.....	173	140	135	.809	.780	84	142	36	43	.....
59	.....	168	135	133	.804	.792	.....	.....	36	40	.....
60	.....	.....	142	133	.....	.....	.....	.....	.....	.....	.....
61	.....	160	142	.....	.888	.....	94	.....	38	40	.....
62	.....	.....	133	.....	.....	.....	96	.....	.....	.....	.....
63	.....	168	140	.....	.833	.....	95	.....	.....	.....	.....
64	.....	165	144	.....	.873	.....	97	.....	.....	.....	.....
65	.....	184	137	.....	.745	.....	93	.....	.....	.....	.....
66	.....	156	149	137	.955	.878	97	133	35	40	.....
67	.....	.....	135	124	.....	.....	.....	.....	.....	.....	.....
68	1500	170	140	151	.824	.888	91	138	32	38	M.
69	1500	174	144	141	.828	.810	97	139	36	44	M.
70	1260	167	135	126	.808	.751	92	132	35	39	F.
71	1340	171	132	141	.772	.825	94	137	34	45	M.
72	1600	177	149	142	.842	.802	94	143	38	47	M.
73	1330	165	143	130	.867	.788	90	119	35	43	M.
74	1390	173	128	132	.740	.763	89	131	33	42	F.
75	1390	171	140	134	.819	.784	96	138	35	40	M.
76	1490	178	139	138	.781	.775	86	138	38	43	M.
77	1540	177	145	147	.819	.831	89	144	37	42	M.
78	1380	175	142	137	.811	.783	91	.....	.....	.....	F.
79	1320	168	138	.....	.821	.....	91	.....	39	41	F.
80	1210	170	122	135	.718	.794	86	136	34	41	F.
81	1250	162	128	133	.790	.821	86	130	35	40	F.
82	.....	173	136	133	.786	.769	95	131	38	43	M.
83	.....	175	140	.....	.800	.....	90	139	34	43	M.
Summary	1660	187	158	151	.955	.894	107	157	39	46	Max.
	1110	151	122	124	.711	.689	84	119	31	37	Min.
	550	36	36	27	.244	.205	23	38	8	9	Range
	1337	169	139	135	.825	.799	93	136	35	40 5	Mean.

* These figures refer to the number of crania measured in each particular respect.

The following notes are based on an examination of the 83 crania given in the above table, and 58 others not yet measured, making 141 in all, this being the entire number sufficiently preserved to be available for measurement, although 662 skeletons, of all ages, have been exhumed to date.

The peculiarities presented by the crania and other bones will be considered under several heads, as follows :

1. General Contour.
2. Size.
3. Special Characteristics of the Various Bones and Cavities.
4. Sutural Peculiarities, including Wormian Bones.
5. Physiological Characteristics of the Long Bones.
6. Pathological Features.

As many of the crania are more or less imperfect, it will be necessary for statistical accuracy to state explicitly under each heading the number of crania examined in that particular connection. The section relating to the crania will be followed by an account of the various physiological and pathological peculiarities observed in other portions of the skeleton.

(1.) As regards their General Contour, the crania are, generally speaking, of the *brachycephalic type*, having a cephalic index (index of breadth) of .800 and over. An examination of the 72 given in the table which are available for study in this respect, shows them to be divided as follows :

Dolichocephali (index of breadth, .730 and under)	3
Orthocephali (index of breadth, .740-.800)	17
Brachycephali (index of breadth, .800 and over)	52
Total, ...	72

In common with most, if not all, North American aboriginal crania, they are also characterized by a markedly *pyramidal form* as viewed anteriorly, this being due chiefly to their great zygomatic diameter, a feature characteristic of the mongoloid races generally.

Flattening of the occiput, also a characteristic of most American aboriginal crania, doubtless due to the custom of strapping infants on a cradle-board, is a rule amongst these to which there are few exceptions; and where, as is often the case, this flattening has been more or less unilateral, *plagiocephalism* or oblique asymmetry of the general cranial development, has resulted.

On the other hand, none of the crania show any traces of the antero-posterior *flattening of the frontal bone*, which is said to have been a custom among the Natchez, Chickasaws, Choctaws, and perhaps some other tribes of this region. The absence of this flattening, so far as it goes, tends to exclude the probability of this people being identical with either of the tribes mentioned.

Prognathism is a generally well-marked, though not constant feature of these crania.

No. 49, in the above table (fig. 1), is remarkable for its great length, both absolute and as compared with its breadth, which latter dimension, however, can not be obtained accurately, as a portion only of the

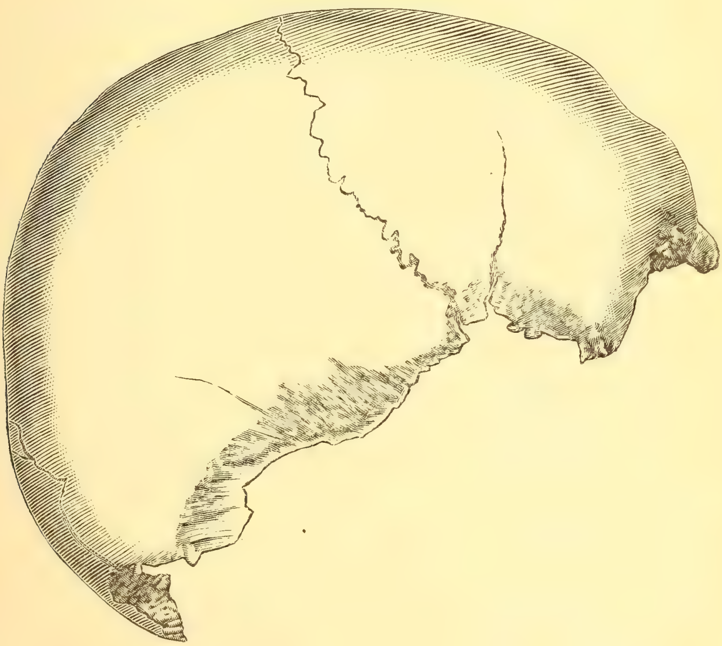

Fig. 1. Cranium remarkable for its peculiar proportions and prominent supra-ciliary ridges (No. 49 on table).

calvarium is preserved. In its peculiar proportions, low, narrow forehead and prominent supra-ciliary ridges, it bears a somewhat striking resemblance to the famous Neanderthal skull, its length, however, being greater, and the forehead narrower.

(2.) With respect to SIZE, numbers 4, 5 and 12 on the table are noticeable as representing the two extremes ; No. 4 being the sixth in point of size of all aboriginal American crania on record.*

The following table of comparative measurements will explain better than words the average proportions of these crania, as compared with those from other localities in North America.

Comparative Table of Cranial Measurements.†

	Capacity.	Length.	Breadth.	Height.	Index of Breadth.	Index of Height.	Width of Frontal.
Mean of 83 crania from Madisonville.	48‡ 1337	78‡ 169	77‡ 139	61‡ 135	72‡ .825	58‡ .799	69‡ 93
Mean of 67 crania from stone-graves in Tenn.	30 1341	67 166	61 141	40 142	.852	.854	91
Mean of 21 crania from stone-graves in Tenn.	18 1335	21 165	21 143	21 141	.872	.854	......
Mean of 38 crania from a mound in Kentucky.	24 1313.33	37 165.4	38 142.28	36 132	.857	.769	92.7
Mean of 10 crania from caves in Ky. and Tenn.	2 1382	10 168	8 140	4 143	.831	.823	90
Mean of crania from mounds in U. S	39 1374	118 168	115 145	78 139	.867	.821	....
Mean of 18 crania from Florida............ ..	7 1375 7	16 173.5	18 145	11 135.6	.830	.777	98.47
Mean of 103 crania from Santa Barbara, Cal....	1248	175	136	129	.779	.741	98
Mean of 50 crania from Islands off Santa Barbara, California.......	1326	184	133	128	.723	.680	93
New England..	......	179	136	136	.759	.759	......
Iroquois..............	....	185	137	137	.740	.740	......
Algonquin	......	184	141	136	.766	.739	.. ..
Algonquin (Lenape) ..	....	180	140	137	.777	.761	......
Esquimaux.....	......	184	132	138	.717	.750	......
Tschuktchi...........	...	176	135	137	.767	.778	.....

The capacity of the average European skull is given by different authorities at 1510 to 1531 c. c. The index of breadth ranges from .750 to .800 in the various European nations, being lowest (.750-.760)

* This skull has been described and figured in a previous paper ; see this JOURNAL, vol. iii., p. 54, plates 2 and 3.

† This table, with the exception of the first item, is taken from the Eleventh Annual Report of the Peabody Museum of American Archæology and Ethnology, 1878, p. 368.

‡ The small figures refer to the number of crania measured in each particular respect.

in the Anglo-Saxons, ancient Romans, and Roman British, and highest in the English (.770), French (.780), German (.790), and Prussian (.800).*

(3.) Special Characteristics of the Various Bones and Cavities of the Head.

The Temporal Process of the Malar Bone.

The writer takes the liberty of reproducing here his description† of this process, with some additional data respecting the frequency of its occurrence.

"A noteworthy anatomical and possibly anthropological feature of a large proportion of the crania from the well known ancient cemetery near Madisonville, Ohio, is the presence of a spine-like and occasionally unciform process, situated on the posterior border of the malar bone and partially covering in the temporal fossa. This projection, for which the writer proposes the name 'temporal process,' is somewhat triangular in shape, its base, which is from 7 to 18 mm. in length, being continuous with the middle third of the posterior border of the bone; it tapers somewhat rapidly to its rather obtuse apex, its length varying from 4 to 8 mm.

"It is of occasional occurrence also in negroes and mulattoes, and further observations as to its distribution and frequency in various races would doubtless be of interest."

Fig. 2 illustrates a well developed example, as seen in many of the Madisonville crania. Of 68 crania from the Madisonville cemetery, observed with reference to this process, it is present to the following extent:

Well developed (attaining a length of 3 mm. and over)...	52
Rudimentary (less than 3 mm.)	13
Absent	3
Total,........	68

In one case it is observed to attain a length of 8 mm., and a width at base of 19 mm.

Since the above announcement of this process, it has been observed in the two Australian crania in the museum of this Society; and in the cranium of a Buginese in the Mussey collection at the Miami Medi-

* *Vide* "Thesaurus Craniorum," by Dr. Barnard Davis, pp. 352-359.

† Read before the American Association for the Advancement of Science at its thirtieth meeting. Cincinnati, August, 1881.

cal College; of three Bengalese crania in the latter collection it is well marked in one, rudimentary in another, and absent in the third.

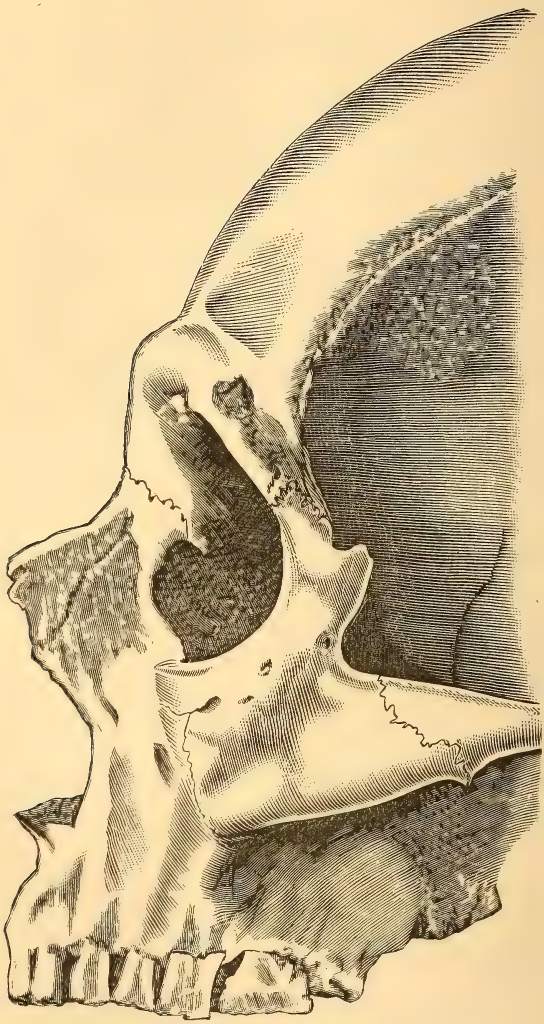

Fig. 2. Illustrating the temporal process of the malar bone.

In 138 modern crania, from various sources,* examined with reference to this feature, it is present as follows:

* Museums of the Miami and Ohio Medical Colleges, and of the Cincinnati Hospital.

Well developed (3 mm. and over in length)	48
Rudimentary (less than 3 mm.)	33
Absent	57
Total	138

The nationalities of these crania can not be ascertained, but it is reasonable to assume that a considerable proportion of them are from negroes and mulattoes.

This process is probably a more or less constant feature in American aboriginal crania generally, and it seems somewhat remarkable that so acute an observer as Morton should have overlooked it in his extensive craniological investigations; such, however, appears to have been the case, as no mention is made of it in his elaborate work, entitled "Crania Americana," although well-marked examples are figured in Plates 11*b* (Peruvian), 12 (Orinoco Indian), 15 (Botocudo), 17 and 18 (Mexican), 19, 20, 23, 25, 28, 30, 31, 37, 39, 41 and 47 (the last eleven all North American Indian).

Peculiarities of the Cavities.

The *orbits* are, to the eye, noticeable for their marked angularity, and for their great width as compared with their height, but as no series of measurements of these cavities in other races is at hand, it is impossible to institute a comparative study of this feature at present.

As regards the *nasal cavities* these do not present, to the eye, any noticeable variation in size as compared with those of Caucasian skulls, but no details of measurement have yet been made on this point.

The *external auditory meatus* in these crania is generally elliptical in form, its long diameter extending vertically or nearly so. *Bony outgrowths* or *tumors* are observable near the outer opening of this canal in five of the 83 crania examined. In three of these instances the exostoses are limited to one side; in the other two they occur in both ears. In one skull the meatus is so obstructed by these growths that its lumen is quite obliterated on one side, and nearly so on the other.

With respect to the other openings of the skull, mention may be made here of a quite general *narrowing of the spheno-maxillary fissure*, due to approximation of the orbital process of the superior maxilla and the orbital surface of the great wing of the sphenoid; these surfaces even articulating slightly in some instances as noted further on under head of sutural peculiarities.

(4.) Sutural Peculiarities, including Wormian Bones.

Persistent Frontal Suture.

In one skull, not yet measured, and consequently not included in the

above table, the frontal suture is persistent throughout, being the only instance of its occurrence noted in an examination of 141 adult crania from this cemetery.

In this connection, the following table relative to the frequency of persistent frontal suture in various races is of interest; it is taken from Peschel, "Races of Man," N.Y., 1876.

NATIONALITIES.	SKULLS With An Open Frontal Suture.	SKULLS Without An Open Frontal Suture.	Proportion of "Crossheads" to ordinary Skulls.
Germans of Halle....................	70	497	1: 7.1
Inhabitants of St. Petersburg........	70	1023	1:14.6
Other Caucasians.....................	14	129	1: 9.2
Mongols..............................	7	96	1:13.7
Malays...............................	5	87	1:17.4
Negroes..............................	1	52	1:52
Americans............................	1	53	1:53

The skull from Madisonville in which this suture is persistent, appears to be that of an individual of from 45 to 50 years of age, and presents various other abnormities, as follows: A so-called "inca" (wormian) bone, situated at the apex of the lambdoid suture; another wormian bone at each end of this suture, and several smaller ones scattered throughout its continuity; six small wormian bones in the left squamo-parietal suture, and one in the same suture on the right side; on the right side one, and on the left two, supernumary bones intervene between the tip of the great wing of the sphenoid and the anterior inferior angle of the parietal.

The *incisive suture* is partially persistent in 18 out of 62 crania examined in that connection.

The so-called "*inca bone*," which is merely a triangular wormian bone replacing the apex of the occipital, is present in 14 of the 88 crania examined in this respect. In two of these it attains a very large size, replacing almost the entire upper half of the occipital. This is the case in No. 79, where the "inca bone" measures 88 mm at the base, and 46 mm, from centre of base to apex, the outline of its lower border being somewhat crescentic. An additional wormian bone, of small size, is placed between it and the parietal on the left of the median line. In the same 88 crania other wormian bones are frequent, being distributed amongst the various sutures, as follows: In the lamdoidal suture in 26 instances, the number of bones in each case varying from one to four or five; in the occipito-temporal, 5 instances; squamo-parietal 1; fronto-parietal, 1; spheno-parietal, 4; spheno-temporal, 1; spheno-malar, 1.

Synostosis, more or less complete, of various sutures, is observed in 13 crania out of 68 examined; the following being the list of sutures affected:

Saggittal	9
Lamdoidal	1
Coronal	8
Squamo-parietal	1
Spheno-frontal	4
Occipito-mastoid	1
Internasal	1

Articulation of the Superior Maxilla with the Sphenoid. Of 55 crania examined with respect to this feature, the orbital process of the superior maxilla articulates directly with the orbital surface of the sphenoid, as follows: On one side only, in three instances; on both sides, in four instances.

(5.) Physiological Characteristics of the Long Bones.

Perforation of the olecranon fossa. Of 34 humeri examined with reference to perforation of the olecranon fossa, this condition was found to be present in 17; it is possible, however, that some of these were selected for preservation on account of this feature, so that any final conclusions drawn from these figures might be fallacious. Wyman,* in an examination of 80 Indian humeri in the Peabody Museum, found 25 perforated (about 31 per cent.); of 52 humeri of whites, this condition was present in only two. It is a quite general characteristic of the Anthropoid Apes.

Plactycneism, or lateral flattening of the tibia, is a well-marked characteristic, but for lack of comparative measurements no definite details can now be given respecting this feature.

Cnemeolordosis, or antero-posterior curvature of the tibia, appears to be tolerably constant, but does not attain a high degree of development except in the diseased tibiæ.

(6.) Pathological Features.

The following notes embrace all cases of disease and injury of the bones observed to date. 662 skeletons have been exhumed, each of which has been carefully examined for marks of disease or injury, and it is believed that few, if any, cases have been overlooked.

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* Fourth Annual Report of the Peabody Museum of American Archæology and Ethnology p. 20, Boston, 1871.

Pathological conditions of the crania.

Ankylosis, complete, of the condyles to the articular surfaces of the atlas, is present in three crania out of the 141 examined. One of these

Fig. 3*a*.

Fig. 3. Ankylosis of vertebral column.
3*a*. Axis and third cervical vertebræ.

belonged to the unfortunate possessor of the spinal column and other bones referred to in a previous paper,* as follows:

* This JOURNAL, vol. iii., p. 139.

"The spine of this individual (see fig. 3) presents an example of a somewhat remarkable pathological condition, the spinous and articular processes of all the dorsal and lumbar vertebræ being ankylosed; *the bodies remain free*, with the exception of two in the lumbar region, which are connected only by a thin band of osseous tissue. The last lumbar vertebra is in its turn solidly united with the sacrum, and the latter bone with the ilia. Several of the carpal and metacarpal bones are also united into a solid bony mass, and the atlas is connected with the skull in a similar manner, altogether making this one of the most interesting cases of disease of the osseous system on record." In addition to the above-named conditions mention should have been made of the fact that the axis and third cervical vertebræ are also united by coalescence of their bodies as well as of their transverse, articular and spinous processes. The heads of all the ribs are likewise ankylosed with the bodies of the vertebræ, and their tubrosities with the transverse processes. While the antero-posterior curvature of the spine is marked, it will be observed that this has not been due, as in Pott's Disease, to a breaking down of the vertebral bodies.

The general implication of the articular surfaces can leave no doubt as to the constitutional nature of the disease, which was probably that now recognized as Chronic Osteo-arthritis, or according to some authors, *arthritis deformans.*

In the above-mentioned skull and one other, evidences of arthritis are present in the *temporo-maxillary articulation*, on the right side; in both cases obliteration of the glenoid fossa has resulted from new bony deposit.

In a second specimen of ankylosis of the occipito-atloid articulation, bony union has likewise occurred between the transverse processes of the atlas and the jugular processes of the occipital.

Two or three of the crania exhibit a carious appearance of the vault of the skull, but whether this is due to inflammatory processes or not, is difficult to determine on account of their advanced state of decay.

Fractures of the Skull and Facial Bones.

Of the 141 crania examined, eleven exhibit evidences of fracture, as follows:

Fracture of the right parietal, extending from the anterior inferior angle upward and backward for 65 mm. through that bone; a deposit of new bony matter along its edges indicates some attempt at repair, which, however, has never been completed.

One specimen shows an indentation of the outer table over the right frontal eminence.

There are two cases of marked indentation of both tables in the posterior parietal region, both evidently the result of blows from a blunt instrument ; one of these is shown in fig. 4.

A marked indentation near the apex of the vertical plate of the frontal bone, probably from same cause as the preceding.

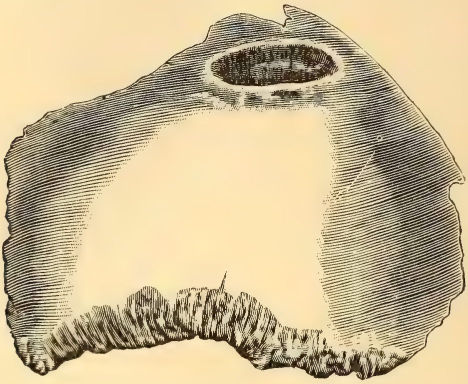

Fig. 4. Depressed fracture of both tables, followed by repair.

Two specimens exhibit perforation of the left parietal, near its posterior border, with marked depression of the inner table ; in both of them recovery has apparently ensued, as the openings are partially

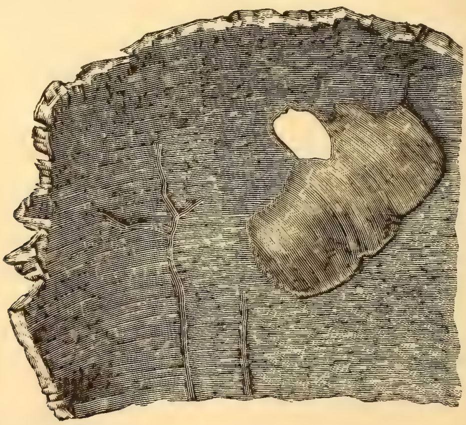

Fig. 5. Perforating fracture of the left parietal near its posterior superior angle; internal view, showing the depressed fragment of the inner table, which has re-united. (Natural size).

closed by new bony deposit, and the remaining edges nicely rounded off. One of these, showing the depressed fragment of the inner table. is represented in fig. 5; the other in figs. 6 and 6*a*.

Figure 7 illustrates the results of an extensive injury to the frontal and right parietal bones, followed by prolonged suppuration and for-

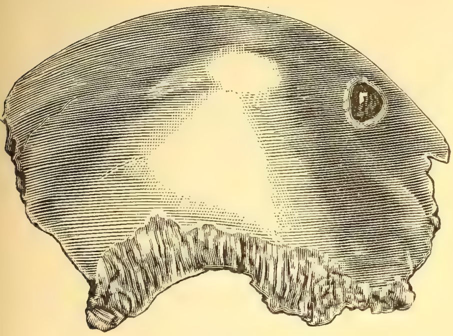

Fig. 6.

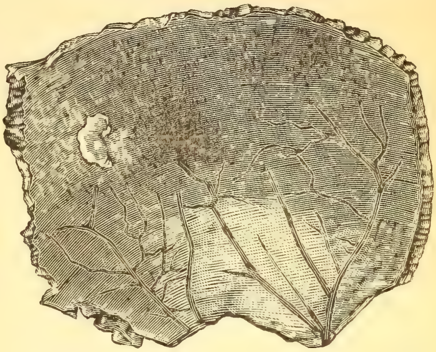

Fig. 6*a*.

Fig. 6. Perforation in posterior parietal region; repair almost complete.
6*a*. Inner view of Fig. 6, showing the depressed fragment of the inner table.

mation of sinuses between the inner and outer tables. There are no evidences of perforation of the inner table at the points of injury shown in the cut, but the opposite frontal eminence shows marks

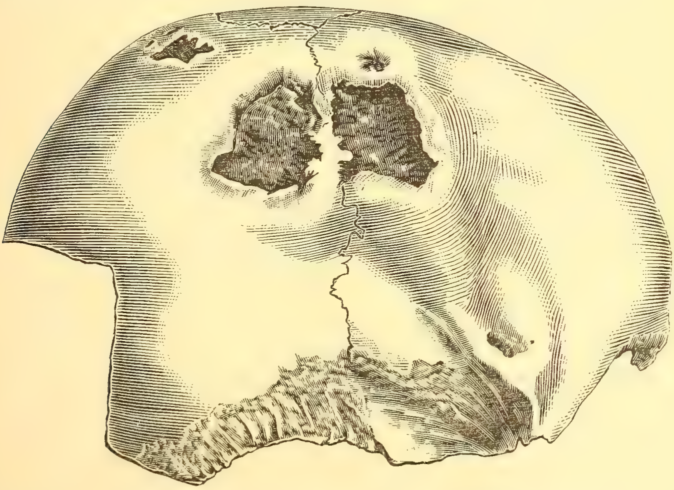

Fig. 7. Results of injury in right frontal and parietal regions, causing extensive sinuses between the inner and outer tables.

of fracture by a blunt instrument, and depression of the corresponding inner table, the depressed fragment being elliptical in form, and 30x12 mm. in extent. Good union has resulted at this point.

In skull No. 41 (fig. 8), an extensive fracture, somewhat stellate in character, involves the right temporal and parietal regions, and has evidently implicated the upper wall of the auditory meatus for nearly an inch from its external orifice. One of the radiating lines extends to the saggital suture near the posterior superior angle of the parietal, and the repair at this point looks suspiciously incomplete. Otherwise, the lines of fracture are nearly obliterated, but a depression remains just above the ear which nicely fits one of the round-headed stone hammers found in the cemetery.

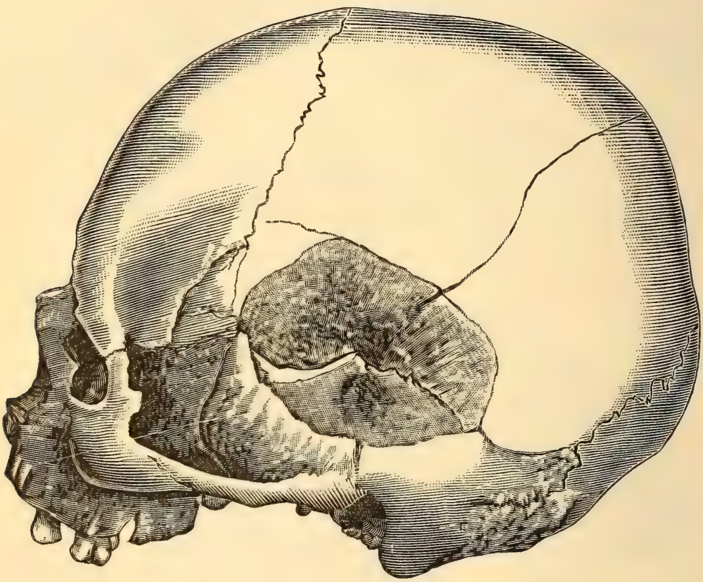

Fig. 8. Stellate fracture, with extensive depression in left temporal region; repair nearly completed.

Just above the external occipital protuberance in another skull, is imbedded a fragment of a small flint arrow-head, about which there are evidences of inflammatory action; penetration of the cranial cavity has not occurred, evidently because of the underlying superior division of the crucial ridge giving increased thickness to the bone at this point.

In one case a line of fracture of the superior maxilla is visible, extending from the base of the nasal process of that bone, diagonally below the orbit to the base of the malar process, involving in its course the rim of the orbit. Repair has been nearly completed with

some displacement backward of the upper fragment. The antrum was perforated by the injury, and this opening still remains patulous.

As regards the remaining bones of the skeleton, aside from the crania, evidences of disease and injury are presented as follows:

Extensive *Osteo-arthritis* of the jaw, vertebræ, ribs, ilia, carpals and metacarpals, etc. (described on p. 249).

Ankylosis of two dorsal and two lumbar vertebræ occurs in another subject.

An *exostosis* on the posterior surface of a sternum near the middle of the gladiolus, apparently the result of repair of fracture.

Arthritis involving a right shoulder joint, with flattening, enlargement and eburnation of the head of the humerus and glenoid fossa.

Arrow wounds: In a dorsal vertebra (the eleventh) is embedded one of the small triangular flints known as "war arrows." It has penetrated the body of the bone about a quarter of an inch to the left of the median line, its course being downward and inward into the body of the next vertebra below. Figure 9 shows the anterior and inferior surfaces of

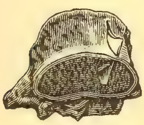

Fig. 9.

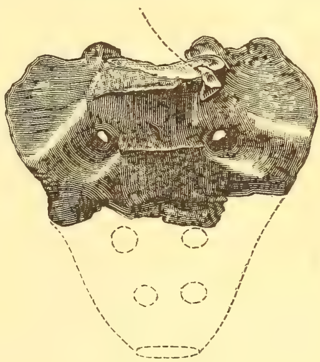

Fig. 10.

Fig. 9. Eleventh dorsal vertebra, penetrated by a flint arrow-head.
Fig. 10. Human sacrum, in which is embedded a flint arrow-head.

the body of the bone, the underlying vertebra having been removed to show the point of the arrow, which has evidently passed directly in the line of the thoracic aorta near its termination.

A sacrum (fig. 10), belonging to another subject, has embedded in its promontory a flint arrow-head which has penetrated the bone from above downward and inward about half an inch to the left of the median line, at the usual point of bifurcation of the left common liac artery. This bone was taken from a pit or ossuary in which twenty-two skeletons were placed.*

* *Vide* "North Americans of Antiquity" by J. T. Short, 2d ed., p. 526; and this JOURNAL, vol. iii., p. 48.

It will be seen from the present position of these two missiles that both must have traversed the body diagonally from before backward. In neither instance are there any evidences of inflammatory action, and the conclusion is therefore warranted that in both cases death has resulted within a short time after receipt of the injury.

An arrow wound of the skull is noted on page 252.

One subject, otherwise normal, presents an example of complete *ankylosis of the coccyx to the sacrum.*

Figure 11 illustrates the results of a *chronic osteitis* followed by "diffuse hypertrophy" of the humerus : its fellow was normal, except that the olecranon fossa was likewise perforated; it came from the same subject as the tibia shown in figure 15.

Fig. 21. Result of fracture of femur above the condyles.

Another humerus exhibits a *spinous exostosis* 9 mm. in length, on the outer side of the shaft at the lowest point of insertion of the deltoid; its appearance would suggest its formation in the tendon of that muscle.

Fracture of the anatomical neck of the humerus has occurred in one instance; good union has resulted with slight displacement of the lower fragment outward. The specimen is not at hand to figure.

Figure 12 represents what appears to be the result of *fracture of*

Fig. 20. Fig. 19. Fig. 18. Fig. 17. Fig. 16. Fig. 15. Fig. 14. Fig. 13. Fig. 12. Fig. 11.

Illustrations of the various lesions of the long bones.

the surgical neck of the humerus; and figure 13 the result, probably, of a "*green stick*" *fracture* of the same bone in its middle third.

The adage that nature is a better physician than surgeon is illustrated by a case of *fracture of the femur* above the condyles (fig. 21). The figure shows the posterior aspect of the bone, and it will be observed that in this instance the lower fragment is displaced forward, and the upper backward, contrary to the usual result in such fractures.

Another femur presents an enlargement on its posterior surface at the lower bifurcation of the *linea aspera*, which appears on section to be due to a simple hypertrophy of the compact tissue; the same specimen shows a small, circumscribed, roughened exostosis on the articular surface of the inner condyle near its posterior border.

The pathological features presented by the tibiæ, include evidences of *periostitis*, *osteitis* and *osteo-myelitis*, in varied combination; as well as *exostosis*, and an obscure form of *rarefaction*.

Figure 14 illustrates enlargement and distortion of the tibiæ following periosteal inflammation ; the evidences of ulceration about the lower half of this bone are somewhat suggestive of *syphilitic* lesions, which supposition is further strengthened by the bilateral character of the disease, and the presence of several nodular excrescences distributed along the crest of the bone.

Figure 15 also illustrates bi-lateral disease with enlargement and distortion of the general contour of the bone, probably the result of *osteitis*; in this case a cross section shows almost complete obliteration of the medullary cavity by extensive deposit of cancellous bone, as well as considerable increase in the density and thickness of the compact tissue,—conditions characterized by the term *osteo-sclerosis*.

Figure 16 represents one tibia of a skeleton exhumed during the excursion of the American Association for the Advancement of Science, on August 22, 1881. It is remarkable for the extreme rarefaction of the bone, the compact tissue being reduced to a mere shell, and the medullary cavity almost filled with an abundant deposit of spongy cancellous tissue. Its fracture was *post-mortem*, due to carelessness of a member of the audience. The disease is bi-lateral, *limited to the tibiæ*, and resembles what is known as *rarefying osteitis*. The subject was a very old person.

Unilateral disease of the tibia resulting in *hyperostosis*, is shown in figure 17.

Osteitis, involving the tibia, and fibula, and resulting in an extensively diffused new bony deposit is illustrated by figs. 18 and 19. Both tibiæ and fibulæ were similarly affected.

Exostosis of Tibia.

A circumscribed spongy or fungous exostosis of the tibia is shown in figure 20. It is limited to the upper half of the bone, and to its posterior and external surfaces, the underlying compact wall being involved in the diseased process to some extent. The same specimen shows a hemispherical cavity with smooth walls and edges, large enough to admit a filbert, in the head of the bone just above its tuberosity.

Correction.—Later advices from the Peabody Museum, necessitate changes in the capacities of two of the Madisonville crania sent to that institution; the effect of these changes is to make the average capacity of the Madisonville crania 1338 c. c., instead of 1337 c. c.

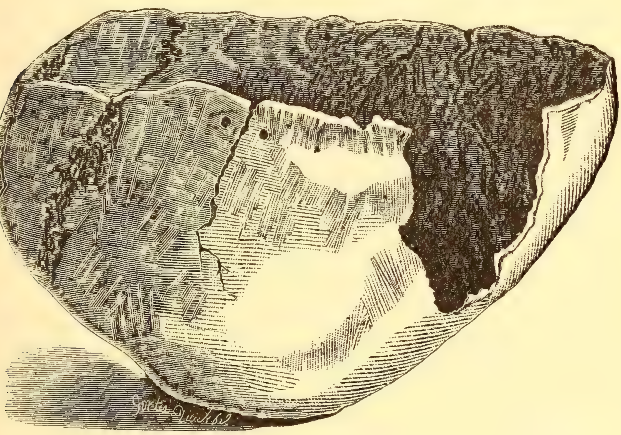

Fig. 22. Aboriginal cup, made from a human skull; exhumed near Brookville, Franklin county, Ind. (To illustrate Mr. E. R. Quick's article in this JOURNAL, vol. iii., pp. 296-297.)

DESCRIPTION OF A NEW SPECIES OF PATULA, AND REMARKS UPON A HYALINA.

By Geo. W. Harper, A.M., Principal of Woodward High School.

Patula bryanti, Harper.

Fig. 1, dorsal view, magnified 3 diameters; fig. 1*a*, ventral view, magnified 3 diameters.

Shell broadly and perspectively umbilicate, discoidal, nearly flat above, and deeply excavated below; whorls, five, gradually increasing, regularly ribbed, outer whorl bicarinate; color, light brown; aperture, small, rhomboidal; peristome, simple, acute, having its extremities united. Greatest width, 6½, least, 5½; height, 2; width of umbilicus, 4½ mill.

Habitat, found buried deeply under old logs.

Locality, Mitchell county, North Carolina.

Discovered by A. G. Wetherby, F. W. Bryant, and Geo. W. Harper.

Note.—The above species bears some resemblance to the carinated varieties of the *P. perspectiva*, and some may consider it a variety of the latter. If it proves to be so, then we are strongly inclined to the opinion that the *P. cumberlandiana* is only a carinated variety of the *P. alternata*, as the analogy between the two is very close.

Fig. 1.

Fig. 1*a*.

Fig. 2.

Fig. 2*a*.

Hyalina significans, Bland.

Fig. 2, dorsal view, magnified 3 diameters; fig. 2*a*, ventral view, magnified 3 diameters.

Shell narrowly, but deeply umbilicated; pale horn color, epidermis, smooth, shining; whorls, six, increasing slowly, last somewhat inflated; irregularly striate, smooth on under side; aperture, lunate; peristome, acute; spire, slightly elevated; base rounded, slightly indented around the umbilicus.

There are three pairs of pearly teeth within the base of the last whorl, which are plainly seen through the shell.

From the peculiar arrangement of the teeth, this shell is readily distinguished from the *H. multidentata*, as the latter has its teeth arranged in rows of five or six in each row. It is a curious fact that as the *H. significans* grows old, its teeth gradually disappear.

Note.—This shell was found by Prof. A. G. Wetherby and myself, while on an exploring expedition in east Tennessee, during the

summer of 1875. They were found in considerable numbers among the leaves under a little clump of trees in a corn field. The spot was afterward cleared and plowed over, so that this rare shell has become extinct in that locality. The above description differs somewhat from Bland's original description of the *H. significans*, but the shell we found is undoubtedly the same.

DESCRIPTION OF NEW SPECIES OF FOSSILS.

By S. A. MILLER, Esq.

TRIGONIA STIEBELI, n. sp.

(Plate VI., fig. 1, view of the left valve ; fig. 1*a*, cardinal view, the right valve of the specimen is unnaturally inflated.)

The shell of this species is very large, subquadrate in outline, and only moderately inflated. The length is a little more than the height. The anterior end extends but slightly beyond the beaks, and is gently rounded below. No lunule. The beaks are small, anterior, slightly incurved, and raised but little above the hinge line. The hinge line is straight and gently sloping backward. The posterior end is subtruncate above, and rounded into the base below. The base line curves up more rapidly toward the anterior end than behind.

About twenty ribs rise from the upper margin behind the beaks, and passing down and curving forward reach the anterior end and basal border. These ribs are very strongly nodulose from the umbonal slope to the anterior and basal margins, and more finely nodulose above the umbonal slope, and between it and the upper margin, though a line of nodules marks the superior border behind the beaks which increase in size toward the posterior end, and another line is directed backward midway between the latter and the umbonal slope. The entire surface of the shell is covered by fine sub-imbricating lines.

The specimen illustrated and described was collected by Bernard O. Stiebel, a naturalist, in whose honor I have proposed the specific name, from strata supposed to be of Cretaceous age, in the southeastern part of Arizona. The author, however, is directly indebted to Prof. Ralph Colvin, through whose kindness the specimen was furnished for definition and who also presented it to him.

Saccocrinus infelix, W. and M.

(Plate VI., fig. 2, view of the left side of a cast of a moderately large specimen; fig. 2*a*, view of the cast of a vault of a small specimen; fig. 2*b*, shows the appearance near the top of the cup when the plates are preserved.)

Megistocrinus infelix, Winchell and Marcy, 1865, Mem. Bost. Soc. Nat. Hist.

Body elongated, somewhat pentangularly obpyramidal, and having depressed interbrachial spaces, without any constriction below the arm bases.

Basals wider than high. First radials, the largest plates of the body and a little longer than wide. Second radials, hexagonal and longer than wide. Third radials, heptagonal and longer than wide. First secondary radials, longer than wide. Second secondary radials, about as wide as long and supporting upon the upper sloping sides a single pair of small tertiary radials, which are followed by a single brachial series, and above which the arms become free.

Regular interradials, twelve or fourteen; the first is hexagonal, and about the size of the second radials; this is followed by three ranges of two plates each ; a fourth range of three plates ; and a fifth and sixth range of two plates each, the latter of which are followed by small plates that graduate up through the interbrachial depressions to the top of the vault. There are four or five inter-secondary radials that are followed by small plates, in like manner, to the top of the vault. The azygous area is much depressed in the upper part, though marked by a convex ridge in the middle of the depression. It is covered by numerous plates. The first is heptagonal and equal in size to the first radials. This is succeeded by three smaller plates, and these by others, which are continued over the convex ridge in the depression to the central part of the vault.

The vault is flat in the central part, with concave depressions toward the interbrachial spaces at the margin, as shown by a specimen having the plates preserved ; the cast, however, shows the prominent radiating arm furrows as represented by fig. 2*a*. It is covered by numerous polygonal plates. There are twenty arms.

This species is distinguished from *S. christyi*, with which it has been confounded, by the more elongated form of the body, by the more elongated plates, by the more pointed form at the base, by the more pyramidal and pentangular shape of the body, by the increased number of interbrachial plates, and by the interbrachial depressions. The latter peculiarity, when the plates are preserved, is alone sufficient

to distinguish it. The difficulty in distinguishing a Bridgeport cast from a Waldron specimen covered with plates, does not exist when we have a Bridgeport specimen with the plates preserved to compare with the Waldron specimen.

The three specimens illustrated are from the collection of W. C. Egan, Esq., of Chicago, Illinois. He has another specimen with the plates on top of the vault, and those on one side preserved as far down as the top of the third primary radial.

Cyathocrinus vanhornei, n. sp.

(Plate VI., fig. 3, view of the left side, also showing the azygous plate—natural size. The lower part of the basal plates on the posterior side have been broken off.)

Body strongly constricted at the middle of the sub-radials, and greatly expanded above on the azygous side. Basals as long, as wide, and the expansion of the cup commencing in the middle part. Subradials large, a little longer than wide, hexagonal and pentagonal, and strongly constricted as above remarked. Radials wider than high, and broadly notched for the reception of the arm plates. There is a single large azygous plate resting upon the upper face of a subradial. The arms are evidently strong, though not preserved in our specimens. Column, unknown. The entire surface of the plates is smooth.

The smooth, round, constricted form of the body will distinguish this species from any other. The casts may also be distinguished by the constricted and elongated form.

The specimen is named in honor of W. C. Vanhorne, general superintendent of the Chicago, Milwaukee and St. Paul R. R., a gentleman who finds time to superintend more than 4,000 miles of railroad, and to study the resources, and the geology and palæontology of the whole country traversed by the roads. The specimen illustrated is from the Niagara Group, at Bridgeport, Illinois, and belongs to his fine private collection, at Milwaukee, Wisconsin.

Glyptaster egani, n. sp.

(Plate VI., fig. 4, side view, natural size; fig. 4*a*, same view magnified; fig. 4*b*, basal view.)

Body of medium size, obpyramidal. Basals small and nearly or quite covered by the column. Subradials well developed, highly convex or protuberant with an inclined face directed toward each suture, thus presenting an hexagonal cutting. The first radials almost regularly hexagonal, and the largest plates of the body; most highly con-

vex at the upper part where they form a flattened angular ridge, which is continued as the form of the succeeding two radial plates and the secondary radials as far as preserved in our specimen. This ridge bifurcates toward the subradials below. The second radials are quadrangular or pentagonal and much wider than high. The third radials are pentagonal or hexagonal, and about as wide as high. Only two or three of the secondary radials are preserved in our specimen.

The first regular interradials are nearly as large as the first radials, octagonal, protuberant, and presenting inclined faces toward each of the adjoining sutures. These are followed by two smaller interradials, and these again by two, beyond which our specimen is not preserved. A single intersecondary plate is preserved in our specimen.

The protuberant plates and numerous cut faces will alone distinguish this species from any hitherto described.

The species is founded upon a single specimen from the collection of W. C. Egan, Esq., in whose honor I have proposed the specific name. It was found in the Niagara Group at Bridgeport, in Chicago, Illinois.

Leperditia cæcigena, n. sp.

(Plate VI., figs. 5 and 5*a*, views magnified about five diameters. These two magnified illustrations are not exactly correct, but near enough for all practical purposes. They were drawn without the aid of photographs.)

Length usually about 12-100 inch, breadth about 8-100 inch. and thickness about 4-100 inch.

General form subovate. Hinge line straight, a little more than half the length of the valves. Anterior end narrower than the posterior, extending but little beyond the hinge line, when it rapidly curves into the ventral line below. The posterior part is broadly rounded, and constitutes beyond the hinge-line full one third the length of the valves. Valves most convex at the posterior third. Surface smooth and eye-tubercle obsolete.

This is a true Leperditia, as one valve overlaps the other.

The author collected this species in the upper part of the Hudson River Group at Versailles, and near Osgood, Indiana. The specimens illustrated and described are in his collection.

THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. IV. CINCINNATI, DECEMBER, 1881. No. 4.

PROCEEDINGS OF THE SOCIETY.

TUESDAY EVENING, *October* 4, 1881.

Dr. R. M. Byrnes, President, in the chair. Present, 20 members.

The Executive Board announced the purchase of the casts of 37 crania, a *Glyptodon*, and parts of a *Mastodon*, *Dinotherium*, *Castoroides ohioensis*, *Plesiosaurus macrocephalus*, *Ichthyosaurus communis*, *Hipparion elegans*, and *Pterodactylus crassirostris*, with the cast of the egg of *Æpyornis maximus*, and some bone implements from the Swiss lake dwellings.

Also the skeletons of *Pteropus edvardsi*, *Apteryx oweni*, *Naja tripudians*, *Uromastrix spinites*, *Rana mugiens*, *Morrhua vulgaris*, *Raja batis*, and the femur of *Loris gracilis*.

L. S. Cotton made some remarks upon the mountain scenery of Europe and America, and was followed upon the same subject by M. D. Burke and J. R. Challen.

Donations were announced as follows:

From Peter G. Thomson, a valuable collection of prehistoric relics, consisting of pottery ware, shell, stone and bone implements, pipes, human remains, etc.; from Joel Brown, a young soft-shelled turtle; from Dr. A. Gattinger, a specimen of granite; from L. Dressel, a specimen of *Dynastes tityrus*; from J. F. James, fossils, plants and insects from New Harmony, Ind., and minerals from Alabama and Texas;

from H. G. Hanks, seven volumes on California geology; from Prof. John Collett, Report on Statistics and Geology of Indiana, for 1880; from Miss Louisa Dyer, five species of Cincinnati fossils; from C. Faber, twelve species of European and North American fossils; from H. Pugh, one lot pamphlets on mollusca; from Macbrair & Sons, three specimens of lithographic stone; from O. T. Mason, five pamphlets on archæology; from Miss Mary Telfair, one mole skin; from J. M. Patterson, five volumes of Ohio geology and twenty-six volumes of maps; from Gideon Mabbett, seven specimens alligators and birds' eggs.

TUESDAY EVENING, *November* 1, 1881.

Dr. R. M. Byrnes, President, in the chair. Present, 18 members.

Mr. Davis L. James presented a large fungus (*Lycoperdon giganteum*), commonly known as the "puff-ball." This species, Mr James stated, as well as all others of the genus, is edible; and when properly cooked much resembles in consistency and flavor, an omelet. It should be eaten when only a day or two old, at which time the flesh is firm and pure white. The specimen was ovoid in shape, and measured about eight by twelve inches. It was supposed to be less than a week old, and when cut open had a deep lavender color and uninviting appearance.

Dr. A. B. Thrasher was elected a regular member of the society.

The President announced the recent death of Prof. William Colvin, who had been a prominent and active member of the society for many years. A committee, consisting of Messrs. S. A. Miller, S. E. Wright and L. S. Cotton, was appointed to draft a suitable memorial of his life and services. A committee, consisting of J. A. Warder, U. P. James and S. T. Carley, was appointed to prepare a tribute to the memory of Mr. John L. Talbott, recently deceased, who was a life member of this society, and a member of the old Western Academy of Natural Sciences.

Mr. A. E. Heighway, Jr., distributed a number of copies of a geological map of Kentucky to the members present.

Donations were announced as follows: From the Chief of Engineers, War Department, 14 volumes of valuable Government reports on geology and zoology, etc.; from Dr. R. W. Shufeldt, U. S. A., two memoirs on Avian Osteology; from Ward and Howell, a cast of a large ammonite; from Jacob Hoffner, Esq., Cumminsville, Ohio, through Dr. A. E. Heighway, the lower jaw of a sperm whale, sixteen feet in length; from A. E. Heighway, Jr., a specimen of *Calymene niagarensis*, from Alabama, and 21 volumes of books and pamphlets on geology; from Dr. A. E. Heighway, a specimen of *Sigillaria*, from Rockwood, Tennessee; from E. O. Hurd, Esq., a specimen of the American bittern, from Alabama; from E. C. Reiss, a specimen of *Bolannus lentiginosus*.

TUESDAY EVENING, *December* 6, 1881.

Dr. R. M. Byrnes, President, in the chair. Present, 12 members.

Samuel R. Matthews was elected a member.

Mr. Joseph F. James read a paper on the Variability in the Acorns

of *Quercus macrocarpa*, which is published elsewhere in this number of the JOURNAL.

Mr. S. A. Miller, chairman of the committee, made the following report:

The committee appointed to prepare a notice of the life and services of Prof. Wm. Colvin, deceased, and an expression of the esteem in which he was held by this Society, report—

That Wm. Colvin was born near Dumfries, in Scotland, in 1820, graduated at Edinburgh in 1839, and then removed to America with his parents. He located at Pittsburg, Penn., and taught school in the western part of that State for several years. Afterward he was connected with the publication of a newspaper, and subsequently was engaged for some years as book-keeper for the firm of Hague, Hartupee & Co., engine builders, where he acquired a very thorough knowledge of machinery. About 1850 he formed an Association for the manufacture of iron, and removed to Ironton, Ohio, where the company constructed and operated an iron mill until about the year 1855, when he removed to Cincinnati. His taste led him to seek the society of the educated, and the friends of the advancement of science, and he at once became a member of the Western Academy of Sciences. He acted here for some time as agent of the Hanging Rock Mill, and afterward became book-keeper for the Marine Railway and Dry Dock company. During a large part of this time he was President of the Board of Education of Woodburn, Walnut Hills, where he resided. When this Society was organized he became an active member, and now, as his voice will no more be heard in the discussion of scientific questions, or in the best methods of building up the association so that it will be of the most benefit to us and those who shall draw information from it in the future, we may all unite in acknowledging the valuable services he rendered to the Society, the unselfish zeal manifested in the treatment of all topics in which he took a part, and in eulogizing his kindness and nobleness of purpose.

He was secretary of the Society from April, 1874, to April, 1875. In 1874 he was appointed to the Chair of Political Economy and Civil Polity in the Ohio Agricultural College at Columbus, where he remained until 1877, after which time he was engaged in examining and settling up books and examining mineral lands as an expert in regard to their value for coal and iron.

Sometime during the last summer he went to Georgia for the purpose of exploring and developing some mineral lands. He was taken sick and died of typhoid fever, at Cartersville, on the 26th of October last. His remains were brought to this city, and interred in Spring Grove Cemetery. Those who carried him to his last resting place were Dr. R. M. Byrnes, L. S. Cotton, S. A. Miller, John B. Peaslee, J. S. Taylor, and Chas. A. Thompson.

He was distinguished for his honesty and the firmness of his convictions. His varied experience and habits of study made him a man of great general information, and his close observation of nature and

love for natural history made him a naturalist and man of science. Indeed, he was a scholar of no ordinary attainments, and will be missed by the philosophers and thinkers of this city, and his associates in almost every branch of natural history, where he was always at home in conversation with our best and ablest specialists.

He was a friend, a scholar, and a gentleman.

S. A. Miller,
S. E. Wright,
L. S. Cotton, } *Committee.*

Mr. V. T. Chambers called attention to the recent death of Prof. J. B. Chickering, and on his motion a committee, consisting of Prof. G. W. Harper, J. W. Hall, Jr., and J. B. Mickelborough, was appointed to draft a suitable testimonial to his memory.

Dr. A. J. Howe, in the absence of the chairman of the committee, made the following report:

The recent death of Mrs. Abigail Warren recalls to the older members of the Cincinnati Society of Natural History, the pleasing remembrance of a generous donation in money, made by the deceased to the Society when it was in its infancy, poor and much in need. This donation, when received, called forth a universal expression of thankfulness, and is still remembered as an important stepping stone in the Society's progress.

We know little of the history of this estimable lady. She was born at Needham, Mass., and after coming to Cincinnati, was married to George Warren, an old and respected citizen, who died several years before her demise. She left no children and no relatives here.

The Society has enrolled her name among its honored benefactors.

The few members who enjoyed the pleasure of her acquaintance gladly testify to her social eminence, refinement and intelligent benevolence, and this Society expresses its sorrow at the demise of its benefactress, and tenders its sympathy to her surviving relatives.

L. S. Cotton,
A. J. Howe,
J. W. Shorten, } *Committee.*

The following donations were announced: From G. D. Richardson, an illustration of the historical elm tree on Boston Common, upon a thin board made from the wood of the tree; from Mrs. S. A. Kendrick, 25 fossils and 16 minerals; from S. T. Carley, a very fine slab of *Glyptocrinus decadactylus*, and a piece of wood showing borings of the Carpenter bee; from Miss Ellison, ten species of ferns, an Indian tobacco pouch, some sea weeds and some fossils; from Joseph F. James, the skin of a snow bird (*Junco hyemalis*), and eight acorns of *Quercus macrocarpa;* from Davis L. James, eight species of seeds; from Prof. F. W. Putnam, one volume and two pamphlets on archæology; from the Smithsonian Institution, the proceedings of the U. S. National Museum for 1881; and from the Department of the Interior two volumes and seven pamphlets on Natural History.

*OBSERVATIONS ON THE UNIFICATION OF GEOLOGICAL NOMENCLATURE, WITH SPECIAL REFERENCE TO THE SILURIAN FORMATION OF N. AMERICA.**

By S. A. Miller, Esq.

The words "system" and "formation" are both in use, in North America, in the nomenclature of the larger geological subdivisions. The former was more generally employed, in the early growth of the science, but is now rarely used, and seems to be gradually growing into disfavor. The latter is preferred, because it is not a technical name, but a word taken in its ordinary signification, and may, therefore, in general, be omitted. Hence, without fear of being misunderstood, we speak of the Lower Silurian, or Upper Silurian, or Devonian, without adding the word "formation." The Silurian includes the entire series of rocks from the base of the Potsdam Group or primordial zone to the Devonian. The Lower Silurian comprises all the rocks from the base of the Potsdam Group to the top of the Hudson River Group, and the Upper Silurian all the rocks from the Hudson River to the Oriskany Group or base of the Devonian.

In the nomenclature of any of the lesser geological subdivisions, we do not employ the word "formation," though, if so employed, it would not necessarily detract from its use, in the nomenclature of the larger subdivisions, because its meaning and force, in the latter case, is too well established to be, in the least, disturbed by other and similar uses.

The words series, layer, deposit, bed, zone, horizon, period, age, epoch, and era are used, in geological descriptions, in their literal and ordinary significations. They are not technical names, nor do they belong to our geological nomenclature as a necessary part of the system, though they may be very conveniently employed when reference is had to time, as the Mesozoic age, or to the character of the rocks, as the limestone deposits, etc., etc.

For the purpose of more definite classification, the Lower Silurian and Upper Silurian have been divided into Groups. A Group generally bears the name of the place where it was first studied and described. This method of nomenclature is preferred, because the geographical name, when combined with the word "group," is sufficiently technical; it can not be used for any other purpose, it can never mis-

* This article was written at the request of the Committee on the Unification of Geologica Nomenclature, for the International Geological Congress, that held its second session in Bologna, Italy, about the 1st of October last.

lead as to the mineral or petrological structure or relative position of the strata, and it indicates the typical locality of the exposure.

Sandstones and conglomerates of various degrees of fineness, limestones of all grades and combinations, shales and marls occur in nearly every group in the Lower Silurian, Upper Silurian, Devonian and Carboniferous; and, for this reason, geological subdivisions can not be established upon the mineral and petrological characters of the rocks. This has been demonstrated too frequently to demand further consideration.

The subdivision into groups is founded, substantially, if not entirely, upon the palæontological characters. The petrography may suggest the subdivision and creation of the group, but its establishment depends upon the fossil contents. The fact, however, that the fossils, from contemporaneous animals, must change more or less, in different degrees of latitude, and in deposits made at various depths of the ocean, and be more or less dependent upon the ocean currents that prevailed, and upon the nature of the sea-bottom, which formed their habitat, has rendered it no easy task to determine equivalency of strata, at short distances, and the difficulties and troubles increase as the petrographic characters change and distance intervenes. The perplexities thus arising are usually overcome, in proportion to the thickness of the strata, which are understood to constitute the group, the greater or less number of species that have been described from it, the more or less accurate information respecting the grouping of the fossils in its various parts, and the different kinds of rocks in which they are thus grouped or associated. It happens, sometimes, that a group is so defined, at one locality, as to show that it is different from any previously defined, and is therefore seemingly worthy to be established; but afterward, from more complete study and comparison of the fossils, it is ascertained that such group is included, in some manner, within a larger one defined elsewhere, and constitutes part of it, and yet the equivalency of the strata can not be ascertained. In such case, we have synonymy and still both names are usually retained. Again, when groups are separable, and have been separately defined, at one locality as the Medina, Clinton, and Niagara Groups of New York, we find that some authors, describing the series of strata equivalent to these groups, at another place, where they can not be readily distinguished from each other, will propose for them when combined a new name, as the Anticosti Group.

Or, perhaps, a better illustration of synonymy of the latter kind is

found in the use, in nomenclature, of the "Cincinnati Group." The Trenton, Utica Slate, and Hudson River Groups had been long established and carefully defined, when some one, supposing, without examination, that the Utica Slate Group did not exist in the vicinity of Cincinnati, and that the rocks belonged either to the Trenton or Hudson River Groups, or to both, proposed to call the exposure the "Cincinnati Group." The black slate which characterizes the Utica Slate Group in New York does not exist at Cincinnati, though calcareous slates and shales of the same age do, but they so graduate into the Trenton Group below, and the Hudson River above, that the lines of separation have not been accurately ascertained. It is very clear, however, that if the Utica Slate Group had thinned out in its extension westwardly before reaching Cincinnati, there would be no excuse for calling the Trenton or Hudson River Group, or both of them together, by a new name. Yet there are some who will persist in using the name "Cincinnati Group," because they don't know whether it is of the age of the Trenton, Utica Slate, or Hudson River Group, or of the age of all three, and they are bound to leave their readers in the same hopeless confusion.

Another kind of synonomy, much more to be deplored, exists, where a group has been named and thoroughly defined, and, for some trivial reason, the geologists of another locality use another name for rocks of the same age without regard to priority in nomenclature. As an illustration, the Calciferous Group was established and defined so as to include rocks other than the calciferous sandrock, and ten years afterward rocks of the same age on the Mississippi river were called the "Lower Magnesian limestone," and the Wisconsin geologists persist in the use of the latter name, because they say the word calciferous is not admissible, in that State, from the lithological character of the rock. A reason that has no application whatever, if the foregoing definition of a group is correct, and a reason if carried out, in all cases, would utterly destroy geological nomenclature, for no system can be established upon lithology.

Many other illustrations of synonymy, founded upon like errors of judgment, might be adduced, without including that larger class proposed by men who have been employed upon State or Government surveys, without the necessary qualifications, and who have suggested names through sheer ignorance and stupidity. These names ought not to be mentioned, even as synonyms, for that is giving to them more consideration than they are entitled to receive, and as to many of them more than was required for their publication.

The correct rule would seem to be, where a group has been named, and the fossils have been so described and illustrated, that it may be identified elsewhere than at the typical locality, that the law of priority should be rigorously enforced.

The larger subdivisions or formations are world wide in their distribution, and it is probable that many of the lesser subdivisions or groups, in distant countries, can be brought into conformity or parallelized; but, at present, we can not hope for unification of nomenclature in the latter respect.

Experience has shown the impracticability of making lesser subdivisions, for the purposes of geological nomenclature, than groups, though it is eminently proper to speak of the marl beds or sandstone layers, in any particular group, or of the *Glyptocrinus* or *Orthis* beds, at any particular locality. Such names are used to characterize the strata at the place described, but not in the higher and more extended sense of a geological subdivision.

Passing now from these preliminary observations, we will briefly review the distribution, thickness, and palæontological characters, so far as the genera are concerned, of all the groups into which the Silurian has been divided in North America. A complete review of all the palæontological characters would involve an enumeration of 3,560 specific names, and so much minute and dry dissertation that we would have a large book opened up before us, instead of an essay embodying the general facts and the judgment of the writer for special use on this occasion.

THE LOWER SILURIAN.

The Lower Silurian is subdivided, in ascending order, into the Potsdam, Calciferous, Quebec, Chazy, Black River, Trenton, Utica Slate, and Hudson River Groups. There are other groups, having a local existence, that can not be exactly correlated with these, though, no doubt, included within them, which will be mentioned as we progress.

In 1838, Prof. Ebenezer Emmons described the petrography of the sandstone, at Potsdam, St. Lawrence county, New York, which he found of considerable thickness, containing fossils, and uniformly overlaid by the Calciferous sandrock of Eaton. He traced it over St. Lawrence and Essex counties, and proposed for it the designation "Potsdam Sandstone." It was subsequently thoroughly described in the New York Reports and other State surveys, and shown to embrace rocks other than sandstones; but it was not until 1863 that it was

fully defined as the Potsdam Group, by showing, as Sir Wm. Logan did, that it consists of a series of strata, including shale and interstratified limestones, as well as conglomerates and sandstone. It has been quite frequently and very properly subdivided into the Upper and Lower Potsdam Groups.

The discovery of fossils in strata below the typical sandstone, and the character of the metamorphosed rocks, at the Taconic mountains, led to the attempt to establish the so-called "Taconic System." Prof. Emmons was certainly correct in many of his discoveries in relation to the order of the strata, but part of his "Taconic system" evidently belongs to the Lower Potsdam, and another part to the Quebec Group of the Canadian geologists.

In 1865, Prof. Bailey and Mr. C. F. Hartt called an exposure of arenaceous, argillaceous, and carbonaceous shales, and clay slates often sandy, with sandstone and quartzite, occupying a narrow valley about 30 miles long and 4 miles wide, superimposed to the northwest and northeast upon rocks belonging to the Huronian Group, and having a thickness of about 4,500 feet, near St. John, New Brunswick, the "St. John Group." These gentlemen, with Mr. Matthew, collected within 200 feet of the base of this great series, fossils which they referred to *Paradoxides*, *Conocephalites*, *Obolella*, *Orthis*, *Discina*, *Orthoceras* and *Theca*, and higher up *Lingula*. They referred the Group to the *primordial fauna*, or *Etage C.* of Barrande, and the Lower Potsdam of America. Subsequently, Prof. Hind referred the rocks to the Quebec Group, and afterward Prof. Dawson proposed to call them the "Acadian Group."

While it may be proper to call these deposits the St. John Group, it never can be, to call them the "Acadian Group," if any regard is to be paid to priority in geological nomenclature. The rocks, however, most clearly belong to the Potsdam Group if we are to be governed, in the determination, by the fossils; for they all belong, so far as they have been determined, to the genera *Eocystites*, *Orthis*, *Discina*, *Lingula*, *Obolella*, *Theca*, *Orthoceras*, *Agnostus*, *Conocephalites*, *Microdiscus*, and *Paradoxides*. *Eocystites* is founded upon a very minute radiated plate, supposed to belong to the order *Cystoidea*, an order that reached its greatest development in the Niagara Group, and so far as one may be able to judge, such a plate would not be considered remarkable, if found, in any of the groups into which the Silurian has been divided. *Orthis* and *Orthoceras* are genera which extend to the Carboniferous, and occur in all the intervening groups, and are not supposed to

specially characterize any of them, though *Orthoceras* reached its most remarkable development in the Black River Group, and *Orthis* in the Hudson River; *Discina* and *Lingula* are genera, probably erroneously determined, but, if correctly, they have lived in all ages since, and are, therefore, not characteristic of any group. *Theca* is found in the Potsdam, and continues to occur as high as the Hamilton Group, or Middle Devonian. *Agnostus* and *Conocephalites* occur in the Potsdam, Calciferous, and Quebec Groups. *Obolella*, *Paradoxides*, and *Microdiscus*, are Potsdam genera, and possibly indicate that the strata belong to the Lower Potsdam. While the authors have not referred any of the forms to the species which have been described from the Upper Potsdam, nevertheless, there is nothing in the general *facies*, to distinguish it as a distinct group. Indeed, it would be an extraordinary and notable occurrence to find the same species in the shales and slates at St. John, New Brunswick, and in sandstone at places as distant as Tennessee, New York, and Minnesota, even if they were of precisely the same age.

The Potsdam Group, in New York, is usually a hard silicious sandstone, white, red, gray or yellowish, and having a thickness of from 100 to 200 feet. The lower portion is frequently a granitic conglomerate, in which masses of rounded and water-worn quartz eight or ten inches in diameter are enveloped. The thickness of this portion is not more than ten feet, but in the extension into Canada it is fully three hundred feet. The sandstone differs in texture and aspect at different exposures. In some places a dark, slaty sandstone, about ten feet in thickness, intervenes between it and the Calciferous; at others, a very coarse brecciated rock intervenes; and, at other places, the passage is very gradual into the Calciferous sandrock. It extends from New York into Vermont, where its thickness is only from twenty to fifty feet, unless other rocks are included in the group than merely the unaltered sandstone.

It passes from New York into Canada, where it soon attains a thickness ranging from 300 to 700 feet, and, at the summit, the sandstone becomes by degrees interstratified with beds of Magnesian limestone, that constitute a passage to the Calciferous. It rests unconformably upon and fills up the inequalities of the underlying Laurentian formation over a great part of the area of its distribution. Below the Chaudiere, it consists, at the base, of red, green, black, and lead-gray shales, and hard arenaceous-calcareous argillites, interstratified with gray sandstones, and of gray limestone and limestone conglomerates, inter-

stratified with black limestones, and black shales, and gray sandstones having a thickness of 700 feet; succeeded by gray sandstones interstratified with black and gray argillo-arenaceous shales, and calcareo-arenaceous bands, and sometimes conglomerates, 700 feet; and this series is followed by 600 feet of conglomerate, holding limestone and quartz pebbles interstratified with black shale, slightly arenaceous, and a gray quartzose sandstone holding flakes of black and greenish shale, and occasional pebbles of limestone; making a total thickness of 2,000 feet.

The ever-varying character of the strata may be observed in its extension to the extreme eastern part of the continent, at Belle Isle, and New Foundland, and likewise westerly, by the way of Lake Huron and the Lake Superior region, across Wisconsin and far into Minnesota. In the vicinity of the trappean rocks of Lake Superior, where volcanic agencies are evident, it attains a thickness of 5,000 feet, and often consists of conglomerates composed of trappean pebbles cemented by a volcanic sand. In other places, it consists of white silicious sand, enveloping pebbles of quartz and patches of slate; and again it has a deep red color, and contains patches of dove-colored clay. It never exhibits, in long distances, a homogeneity of structure, or uniformity in thickness, and not unfrequently it takes into its composition, in the upper part, particles of lime, and finally graduates into the overlying Calciferous.

It has an enormous development in the Appalachian mountains, and particularly in Tennessee, where it consists, at the base, of coarse, gray conglomerates, talcose, chlorite and clay slates, interstratified, and having a semi-metamorphic aspect, and a thickness of 10,000 feet. In some places the conglomerate predominates over the slates, and has a thickness alone of 6,600 feet. This great thickness is succeeded by heavy-bedded sandstones, sometimes having sandy shales and thin flags interstratified, and containing scales of mica, and at other times green grains of glauconite; thickness, 2,000 feet. This is followed by hard, brown, greenish and gray shales, and thin sandstones, interstratified with which are several layers of hard, dark, gray sandstone, the whole being 1,000 feet thick; this by soft variegated shales 2,000 feet thick; and this again by a heavy series of dolomites and limestones, 4,000 feet in thickness; making a total thickness of 19,000 feet. Interstratified with the variegated shales, at intervals, are layers of blue limestone, which are often oolitic, and sometimes fossiliferous.

It is well exposed in Missouri, Texas, and many places in the Rocky

Mountain region, where it presents the usual variety of lithological characters. In some localities it is a conglomerate of more or less water-worn pebbles, mostly whitish crystalline quartz, and varying from $\frac{1}{8}$th to 4 inches in diameter, cemented together with a silicious paste. Some of the pebbles are scarcely worn, while others are quite smooth. At other places, the sandstone contains micaceous particles, and often calcareous matter, and sometimes seams occur from 2 to 4 inches in thickness, almost entirely composed of *Obolella* and *Linguloid* shells.

This Group contains ripple marks, wave lines, mud cracks, animal tracks and worm burrows, but such things occur even to the present day, though we distinguish the Potsdam tracks by the names *Climachtichnites* and *Protichnites*, and the burrows by *Scolithus*, a generic name, which is also applied to fossils in the Hudson River and Medina Groups. And there are *Nereits*, *Myrianites*, and *Nemapodia*, of uncertain affinity.

In the vegetable kingdom, we have *Palæophycus*, which occurs in the Calciferous, Hudson River, Medina, Clinton, and as high as the Coal Measures; *Buthotrephis*, which occurs in the Calciferous, Trenton, Utica Slate, Hudson River, Clinton, and Waterlime Groups; *Arthraria*, which occurs in the Trenton and Hudson River; and *Eophyton* and *Cruziana* which are peculiar to it.

The Protista are represented by *Archeocyathus*, which occurs in the Calciferous, and *Protocyathus* which is peculiar to it.

The Polypi are represented by *Dendrograptus*, which occurs in the Quebec, Utica Slate, Hudson River, and Niagara Groups; and *Oldhamia*, which occurs in the Trenton.

The Echinodermata are represented only by *Eocystites* above mentioned.

The Brachiopoda are represented by *Orthis*, *Obolella*, *Discina* and *Lingula*, as above mentioned; by *Crania* and *Orthisina* which occur in the Calciferous, Trenton, Hudson River, and other Groups as high as the Coal Measures; by *Leptæna* which occurs in the Trenton, Utica Slate, Hudson River, Clinton, Lower Helderberg, and Oriskany Groups; by *Camarella*, which occurs in the Calciferous, Quebec, Chazy, Black River, Trenton, Hudson River, and Clinton Groups; by *Lingulella* and *Trematis*, which occur in the Trenton and Hudson River; by *Lingulepis*, which occurs in the Chazy; by *Acrotreta* and *Iphidea* which occur in the Quebec; and by *Kutorgina*, which alone is peculiar to it.

The Pteropoda are represented by *Theca*, as above mentioned; by *Hyolithes*, which extends to the Hamilton, and by *Hyolithellus*, which is peculiar to it.

The Gasteropoda are represented by *Bellerophon*, *Platyceras*, *Pleurotomaria* and *Straparollus*, which occur in every group as high as the Coal Measures. *Pleurotomaria canadensis* is known as a species to pass up into the Calciferous. By *Holopea*, which occurs in every group to the Warsaw in the Subcarboniferous; by *Ophileta* which occurs in the Calciferous, Quebec, Trenton and Galena; by *Straparollina*, which occurs in the Quebec and Black River Groups; and by *Palæacmæa* which alone is peculiar to it.

The Cephalopoda are represented only by *Orthoceras* as above mentioned.

The Annelida are represented by *Serpulites*, which is accredited to the Chazy, Trenton and other groups as high as the Coal Measures. and by *Salterella*, which occurs in the Trenton.

The Crustacea are represented by *Agnostus*, *Conocephalites*, *Microdiscus*, and *Paradoxides*, above mentioned; by *Leperditia*, which occurs in the Calciferous, Quebec, Chazy, Trenton, Utica Slate, Hudson River, Clinton, Niagara, and on to the Carboniferous; by *Bathyurus*, which occurs in the Calciferous, Quebec, Chazy, Black River and Trenton; by *Amphion* and *Arionellus*, which occur in the Calciferous, Quebec and Chazy; by *Bathyurellus*, *Bathynotus*, *Crepicephalus*, *Pthychaspis*, *Olenellus*, and *Menocephalus*, which occur in the Quebec; by *Illænurus*, which occurs in the Calciferous; and by *Aglaspis*, *Agraulos*, *Anopolenus*, *Chariocephalus*, *Conocoryphe*, *Pemphigaspis*, *Solenopleura*, and *Triarthrella*, which are peculiar to it.

It thus appears that less than one third of the genera found within the whole range of rocks, which intervene between the metamorphosed Huronian series and the Calciferous, that have been included in the Potsdam group, are unknown in later times ; more than one third pass up into higher groups, but not beyond the Lower Silurian; of the remainder, a few became extinct in the Upper Silurian, a few in the Devonian, and the rest amounting to about twenty per cent. occur in the Carboniferous, and some in later formations.

Or, in other words, more than two thirds of the genera known from the Potsdam occur in higher groups, and it is linked specifically with the succeeding Calciferous as well as graduating into it as above stated. There is nothing in the thickness, structure or fossil contents as it spreads over the States from the Appalachian mountains, that demands a subdivision beyond the provisional one of Upper and Lower Potsdam, and within the mountain districts, where it is found in such enormous thickness, it has not been separated into groups by satisfactory defini-

tion. Nor can there be any argument drawn from the distribution of the fossils, that will separate it from other Lower Silurian groups by stronger lines than those which distinguish groups in other formations.

The word "Cambrian," in its application to this group is not admissible, because it is part of the Lower Silurian. Beside, the word "Cambrian," for want of proper definition, ranks for uncertainty, even in England and Wales, with the word "Taconic" in America. There are some who use such mongrel names as "Cambro-Silurian" and "Siluro-Cambrian," which have about as accurate significance, in geological nomenclature, as Cretaceo-Pliocene would have, or as *Orthocero-Calymene* would have in palæontology, if one should apply it to a trilobite found within an *Orthoceras*, or *Platycero-Goniasteroidocrinus* applied to a *Platyceras* attached to the vault of a crinoid. Or, a better illustration still, in order to settle all questions relating to *Chetetes* and *Monticulipora* just call the names *Monticuliporo-Chetetes*, or *Cheteto-Monticulipora*. How absurd!

The Calciferous Group.—This group was first defined by Lardner Vanuxem, in 1842, in the Geology of the Third District of New York. He defined and united into one division, the silicious layers above the Potsdam sandstone, with the "Calciferous sandrock" or "Transition rock," of Prof. Eaton, and the "Bark-like layers" of Eaton, or "Fucodial" layers of the early New York geologists, under the name of the Calciferous Group.

In New York, the lower part is compact and silicious, and graduates into the Potsdam below, the middle part is a sandy limestone having a shattered appearance, and the upper part is apparently a mixture of calciferous material with compact limestone. The thickness is from 250 to 300 feet. It extends from New Jersey across New York into Vermont, where the prevailing character is that of a sandy limestone, compact and thickbedded, and having a thickness in the broken up mountain ranges of 300 feet. From New York it extends into Canada, where it is, generally, a granular magnesian limestone, covers several thousand square miles, and reaches a thickness of 450 feet. It occurs on the Mingan Islands, 500 or 600 miles to the northeast, and is finely exposed in Newfoundland, where it consists of definitely stratified limestone having a thickness of 2,000 feet or more.

It occurs in the Lake Superior region, on the St. Mary's, Escanaba and Menomonee rivers, and extends westerly across the State of Wisconsin into Minnesota. It is seen in the bluffs of the Mississippi, from the Falls of St. Anthony to the mouth of the Wisconsin river.

The thickness near the head of Lake Pepin is 185 feet, but south a few hundred miles in the State of Missouri it expands to a thickness of 1,300 feet. It exposes a thickness in northwestern Texas of about 400 feet, and occurs at many other places in the far west.

The genera which are first known to make their appearance in this group, are distributed as follows:

Among the Protista, *Calathium* occurs in the Quebec and Chazy; *Receptaculites* in the Trenton, Hudson River and Niagara; *Rhabdaria*, *Ribeira*, and *Trichospongia*, are peculiar to it.

Among the Polypi, *Monticulipora* occurs in the Chazy, Trenton, Utica Slate, Hudson River, Clinton, and as high as the Devonian.

Among the Gasteropoda, *Euomphalus*, *Murchisonia*, and *Metoptoma*, occur in almost every succeeding group to the Coal Measures; *Subulites* in every group to the Guelph; *Trochonema* and *Helicotoma* occur as high as the Upper Helderberg; *Eunema* occurs in the Black River and Niagara; *Maclurea* occurs in the Quebec, Chazy, Black River and Trenton; and *Scævogyra* is peculiar to it.

Among the Cephalopoda, *Piloceras* occurs in the Quebec.

Among the Lamellibranchiata, a class unknown in older rocks, *Cypricardites* occurs in nearly every succeeding group to the Carboniferous; and *Euchasma* occurs in the Quebec.

Among the Crustacea, *Dolichometopus* occurs in the Quebec.

Of the nineteen genera mentioned, four are peculiar to the Calciferous, five pass into higher groups, but not beyond the Lower Silurian, three terminate in the Upper Silurian, three in the Devonian, and four in the Carboniferous.

This group is connected with the Quebec by numerous species, which occur in both, among which are *Ophileta uniangulata*, *Holopea dilicula*, *Helicotoma perstriata*, *Pleurotomaria calcifera*, *P. postumia*. *Maclurea matutina*, *M. sordida*, *Ecculiomphalus canadensis*, *Camarella calcifera*, *Lingula mantelli*, *L. irene*, *Amphion salteri*, *Bathyurus cordai*, *B. conicus*, and *Asaphus canalis*, the latter also occurring in the Chazy. It, also, so graduates into the Quebec, at some localities, that no distinguishing line of separation has been observed.

The Quebec Group.—This group was first characterized, and its position between the Calciferous and Chazy determined, by Prof. E. Billings, in 1862. It was further defined in 1863, in the Geology of Canada, and its fossils afterward more fully described by Prof. Hall, in Decade II. of the Survey of Canada, and by Prof. Billings in his Palæozoic Fossils.

With the exception of a small portion on the north shore, between Cape Rouge and Quebec, and part of the island of Orleans, it is entirely confined to the south side of the St. Lawrence; where its northwestern limit occurs between Missisquoi Bay and Cape Rouge; and southeastern limit is traced from Stanstead, east of Lake Massawippi, to St. Francis river, and along this river to Lake St. Francis. From this the southern boundary is traced to Vandreuil, on the Chaudiere; thence to the northern part of Lake Temisconata, and following the province line to Lake Metis. It then stretches eastward to the exremity of the continent at Cape Rosier. It reaches its greatest breadth on the Chaudiere, which is about sixty miles. It forms the continuation of the Green Mountains of Vermont, and includes in Canada the Shickshock and Notre Dame Mountains, and has a thickness estimated at more than 12,000 feet. Part of it may belong to the upper part of the Calciferous, and another part to the Chazy, but it is exposed only in a region much disturbed by volcanic action, and how much if any of it is synchronous with other groups may never be known.

The Chazy, when found superimposed upon the Calciferous, is always uncomformable, but when the Quebec intervenes, the connection is shown by the gradual change in the fossils from the Potsdam and Calciferous below to the Chazy and Trenton above.

The genera, so far as known, that make their first appearance in this group, are distributed as follows:

Among the Protista, *Trachyum* is peculiar to it.

Among the Polypi, *Callograptus* and *Ptilograptus*, recur in the Niagara; *Thamnograptus* in the Hudson River and Niagara; *Dictyonema* in the Trenton, Niagara and Hamilton Groups; *Graptolithus* and *Retiolites* in the Clinton; *Climacograptus*, *Diplograptus* and *Retiograptus*, in the Trenton, Utica Slate and Hudson River; while *Cladograptus*, *Dawsonia*, *Didymograptus*, *Discophyllum*, *Monograptus*, *Nemagraptus*, *Nereograptus*, *Phyllograptus*, *Staurograptus*, and *Tetragraptus*, are peculiar to it.

Among the Echinodermata, *Stenaster* occurs in the Trenton and Hudson River; and *Palæocystites* in the Chazy.

Among the Brachiopoda, *Strophomena* occurs in every succeeding group to the Devonian; *Stricklandinia* in the Clinton and Niagara; and *Porambonites* in the Black River Group.

Among the Gasteropoda, *Cyrtolites* and *Metoptoma* occur as high as the Carboniferous; *Cyclonema*, as high as the Devonian; *Fusispira*, in the Trenton, Utica Slate, and Hudson River; and *Clisospira* and *Ecculiomphalus* in the Trenton.

Among the Cephalopoda, *Nautilus* is a living genus, though it should be considered doubtful as to identification in such remote ages; *Cyrtoceras* occurs in every group to the Coal Measures; *Trochoceras* to the Devonian; *Lituites* to the Niagara; *Endoceras* to the Hudson River; and *Cyrtocerina* to the Black River Group.

Among the Lamellibranchiata, *Tellinomya* occurs in the Black River, Trenton, Hudson River, and as high as the Devonian; and *Eopteria* if distinct from *Euchasma* is peculiar to it.

Among the Crustacea, *Beyrichia* occurs in every group to the Coal Measures; *Lichas* occurs in the Chazy, Black River, Trenton, Hudson River, Niagara, and Lower Helderberg; *Illænus*, *Ceraurus*, and *Encrinurus*, in the Chazy, Black River, Trenton, Hudson River, Clinton and Niagara; *Harpes* and *Asaphus* in the Chazy, Trenton, Utica Slate and Hudson River; *Olenus* in the Hudson River; *Triarthrus* in the Utica Slate; *Remopleurides* in the Chazy and Trenton; *Ampyx* in the Chazy; and *Endymionia*, *Harpides*, *Holometopus*, *Megalaspis*, *Nileus*, *Ogygia*, *Shumardia*, and *Telephus*, are peculiar to it.

Of the fifty-seven genera that are thus supposed to have commenced their career in this group, twenty did not pass beyond it, but ten of these are Graptolitidæ, a family that commenced an existence in the Potsdam, and reached the climax of its evolution in this group, and declined gradually, thereafter, though the largest known form existed in the Hudson River Group. Eight of the remaining ten belong to the Trilobites, an order that flourished in the Potsdam, and was in the height of its evolution in this age, but continued to survive until near the close of Palæozoic time. Seventeen of the genera passed into higher groups, but not beyond the Lower Silurian; ten became extinct in the Upper Silurian; five in the Devonian; four in the Carboniferous; and one is supposed to have survived all vicissitudes to the present time. It is connected specifically with higher groups by *Maclurea atlantica*, which passes up into the Chazy; and by *Leptæna sericea*, which occurs in the Chazy, Black River, Trenton, Utica Slate, Hudson River, and Clinton.

The limits of the group are still a subject of discussion, but the existence of it between the Calciferous and Chazy, seems to be firmly established.

The Chazy Group.—In 1842, Prof. Emmons defined this group under the name of the "Chazy limestone." The name is derived from the town of Chazy, in New York, where he found it well exposed between the Calciferous and Birdseye limestone, and having a thickness

of 130 feet. It consists of a dark, irregular, thick-bedded limestone, sometimes containing rough, flinty or cherty masses. It crosses over into Vermont, where it covers more surface than any other group of the Lower Silurian, and has a thickness of 300 feet.

In 1863, the Canadian geologists, finding the limestone associated with shales and sandstones, called it the "Chazy formation." It covers a considerable area in Canada, reaching as far as the Mingan Islands, and sometimes exposing a thickness of 300 feet. It appears in the Lake Superior region where the bottom layers are arenaceous, and higher up they have an argillo-calcareous composition. It extends westwardly across the State of Wisconsin into Minnesota, where it is usually a quartzose, incoherent sandstone, and bears the name of the St. Peters sandstone, from its development on a river of that name. In this region it fills the deep hollows that had been worn out of the Calciferous group before its deposition. It sometimes varies from a foot or less to 200 feet or more in thickness, within a very short distance—the variation of a hundred feet not unfrequently taking place within a quarter of a mile.

In Tennessee, it consists of a blue, more or less, argillaceous limestone, having a thickness of 600 feet, succeeded by red and gray marble, valuable for building and ornamental purposes, 400 feet in thickness. It occurs in Missouri, Nevada, Utah and other places in the Rocky Mountain region. Though a group of no very great thickness, it has an extensive geographical range, and in some places is quite fossiliferous. In New York it so graduates into the Birdseye limestone that constitutes the base of the Black River Group, that some of the early geologists united them into one group.

The genera, whose appearance is first known in this group, are distributed as follows :

Among the plants, *Rusophycus* occurs in the Black River, Trenton, Hudson River, and Clinton Groups.

Among the Protista, *Eospongia* is peculiar to it.

Among the Polypi, *Streptelasma* and *Columnaria* occur in the Black River, Trenton, Hudson River, Clinton and Niagara; and *Bolboporites* is peculiar to it.

Among the Echinodermata, *Rhodocrinus* recurs in various groups as high as the Carboniferous; *Hybocrinus*, *Palæocrinus*, and *Glyptocystites* occur in the Trenton; and *Blastoidocrinus*, *Malocystites* and *Pachycrinus* are peculiar to it.

Among the Bryozoa, *Fenestella* occurs in nearly every group as high as the Coal Measures; and *Stictopora* in every group to the Devonian.

Among the Brachiopoda, *Rhynchonella* occurs in nearly every group to modern time.

Among the Gasteropoda, *Capulus* extends to the Coal Measures; *Bucania* to the Lower Helderberg; *Raphistoma* to the Niagara; and *Scalites* to the Trenton.

Among the Cephalopoda, *Actinoceras* extends to the Carboniferous; *Oncoceras* to the Niagara; and *Ormoceras* to the Clinton.

Among the Lamellibranchiata, *Modiolopsis* to the Lower Helderberg; and *Ambonychia* to the Niagara.

Among the Crustacea, *Sphærexochus* occurs in the Black River and Niagara Groups.

Of the 24 genera that come into an existence in this group, five do not pass beyond it; four terminate in groups belonging to the Lower Silurian; nine in the Upper Silurian; one in the Devonian; four in the Carboniferous; and one has existed through all succeeding time.

This group not only graduates lithologically into the Black River, but it is connected intimately by numerous species, some of which pass into the Trenton and Hudson River Groups. *Strophomena alternata*, and *S. incrassata*, pass up into the Hudson River; and *Orthis borealis, O. disparilis, O. perveta*, *Leperditia canadensis*, *L. louckana*, *L. amygdalina*, *Orthoceras multicameratum*, *O. bilineatum*, *Modiolopsis nasuta*, are among those that pass up into the Trenton Group. The separation from the Black River is however very marked where the passage beds formed by the Birdseye limestone do not intervene.

The Black River Group.—This Group was defined by Lardner Vanuxem in 1842, and named from Black River, New York. It includes the Birdseye and Black River limestones. The Birdseye received its name from the crystalline spots of a species of *Tetradium*, and a fucoid, which are shown when the rock is fractured. It is distinguished by its light dove color, thick layers, and vertical joints. It is found in Essex, Clinton, Lewis, and Jefferson counties, New York, having a thickness of 30 feet. It has been identified in a few other places in the State and also in Vermont, but in Canada it has become so united with other strata, that no line of separation can be determined.

Phytopsis, *Stromatocerium*, *Tetradium*, *Orthostoma*, and *Colpoceras* are genera that appear for the first time in the Birdseye limestone, but all of them occur in the Black River limestone, *Colpoceras* occurs also in the Trenton, and *Tetradium* in the Trenton and Hudson River, and as so many species range into the Black River limestone, there is not sufficient reason for ranking it higher than beds of passage forming the lower part of the Black River Group.

The Black River limestone in New York is usually a gray, compact or subcrystalline limestone, or blue compact limestone, and distinguished by the remarkably large specimens of *Orthoceras* that occur in it. Some of them are ten feet in length, and a foot in diameter. The thickness is about 50 feet. In Vermont it constitutes the black marble of Isle La Motte, where its thickness is from 12 to 20 feet.

The Group spreads over quite an extensive area in Canada, rarely attaining any great thickness, though on the St. Lawrence 90 miles below Quebec, it has a thickness of 136 feet. Its existence has been noted in the Lake Superior region on St. Mary's, Escanaba, and Menomonee rivers, on St. Joseph and Sugar islands, and at Plattsville, Wisconsin. In Missouri, it forms exposures 75 feet in thickness. In Pennsylvania, it is said to have very great thickness, but the geological surveys of that State have been so poor, and so much worthless synonymy has been injected into the reports that one can not acquire much information about its geology without personal examination, or without waiting until after a geological survey shall be organized anew.

The distribution of the genera which commence an existence in this group is as follows:

In the vegetable kingdom, *Licrophycus* occurs in the Trenton and Hudson River, and *Phytopsis* is peculiar to it. Among the Protista, *Astylospongia* occurs in the Trenton and Niagara, and *Stromatocerium* in the Trenton.

Among the Polypi, *Stromatopora* and *Petraia* occur in succeeding groups as high as the Devonian; *Calapœcia* occurs in the Hudson River and Clinton, and *Tetradium* in the Trenton and Hudson River.

Among the Brachiopoda, *Streptorhynchus* occurs in nearly every succeeding group to the Permian; *Dinobolus* occurs in the Guelph; and *Eichwaldia* in the Niagara.

Among the Pteropoda, *Pterotheca* occurs in the Trenton and Hudson River.

Among the Gasteropoda *Loxonema* occurs as high as the Permian; *Eunema* as high as the Devonian, and *Orthostoma* is peculiar to it.

Among the Cephalopoda *Gyroceras* and *Phragmoceras* occur in various groups to the Subcarboniferous; *Gomphoceras* occurs as high as the Hamilton; *Colpoceras* and *Gonioceras* occur in the Trenton; and *Conoceras* is peculiar to it.

Among the Lamellibranchiata, *Conocardium* occurs in various groups as high as the Subcarboniferous, and *Lyrodesma* occurs in the Trenton and Hudson River.

Among the Crustacea, *Isochilina* occurs in the Trenton, Hudson River, and Medina, and *Cytherina* and *Cytheropsis* in the Trenton.

Of the 25 genera thus enumerated as commencing an existence in this group, only three are peculiar to it; eight become extinct in the Trenton and Hudson River; five in the Upper Silurian; four in the Devonian; and five in the Carboniferous and Permian. This group is especially distinguished for the wonderful evolution of the Cephalopoda which it presents. One fifth of all the genera belonging to this class in the Palæozoic rocks came into existence in this group. One genus commenced and terminated its existence, and the family *Orthoceratidæ* that commenced its career in the Potsdam passed its period of greatest development here, though some species survived until the age of the Coal Measures.

The Trenton Group.—This group was named from Trenton, Oneida county, New York. The limestone, at Trenton Falls, where it is over 100 feet in thickness, was called the "Trenton limestone," long prior to the use of the words in a geological sense. In 1838, Lardner Vanuxem referred to the Trenton limestone, but it was not until 1842 that he and Prof. Emmons so defined the group as to fully establish it.

At Trenton Falls, it consists, in the lower part, of a dark-colored, fine-grained limestone in thin layers, separated by black shale or slate, which forms the great mass through which the creek has worn its channel, and in which are all the falls; the upper part is a gray, coarse-grained limestone in thick layers. It is finely developed in Lewis, Oneida, Herkimer and Montgomery counties, where its thickness is about 300 feet, and still more extensive in Clinton and Jefferson counties, where it has a thickness of 400 feet. It also occurs in other counties of the State. In Vermont there are three narrow outcrops, consisting of black schistose layers, associated with slaty seams of limestone, and occasional argillaceous matter, having a thickness of about 400 feet. It has an extensive geographical distribution in Canada. The Montreal, Bay St. Paul, and Ottawa sections have, each, a thickness of 600 feet. The sections in western Canada, on the Trent river, and at Collingwood, have a thickness of more than 750 feet. It is much thinner farther west in Wisconsin and Minnesota. In Missouri it is more than 300 feet thick. In eastern Tennessee it consists, at the base, of a highly ferruginous sandy limestone, having a thickness of 700 feet, followed with flaggy limestone and calcareous shale, 800 feet thick, and this again by variegated marble 300 feet. In middle Tennessee, and central Kentucky, the thickness is about 500 feet. The

Galena limestone of Illinois, Iowa and Wisconsin, belongs to the upper part of this group. It is found almost everywhere on the continent where Lower Silurian rocks are exposed, and in all cases is very fossiliferous. The distribution of the genera that are first observed in this group is as follows:

Among the Protista, *Beatricea* passes up to the Clinton; *Pasceolus* to the Hudson River: and *Brachiospongia* and *Cnemidium* are peculiar to it.

Among the Polypi, *Aulopora* passes up through the Upper Silurian and Devonian : *Palæophyllum*, *Protarea* and *Stellipora* to the Hudson River; and *Buthograptus* is peculiar to it.

Among the Echinodermata, *Agelacrinus* passes up to the Subcarboniferous; *Homocrinus*, and *Palæaster* to the Devonian; *Thysanocrinus*, *Petraster*, *Lecanocrinus*, *Glyptocrinus*, and *Dendrocrinus* to the Niagara; *Carabocrinus*, *Cyclocystoides*, *Heterocrinus*, *Lichenocrinus*, *Palæasterina*, *Pleurocystites*, *Porocrinus*, and *Retiocrinus* to the Hudson River; and *Amygdalocystites*, *Ateleocystites*, *Cleiocrinus*, *Comarocystites*, *Edrioaster*, *Hybocystites*, *Schizocrinus*, *Scyphocrinus*, *Syringocrinus*, and *Tæniaster* are peculiar to it.

Among the Bryozoa, *Ptilodictya* passes up to the Coal Measures; *Alecto*, *Ceramopora*, *Clathroporo*, and *Retepora*, to the Devonian; *Escharopora*, *Paleschara*, and *Phænopora* to the Upper Silurian; *Bythopora* to the Hudson River, and *Arthroclema* is peculiar to it.

Among the Brachiopoda, *Atrypa* and *Pholidops* pass up to the Devonian; and *Zygospira* and *Rhynchotreta* to the Lower Helderberg.

Among the Pteropoda, *Conularia* passes up to the Kaskaskia Group of the Subcarboniferous, and *Tentaculites* to the Chemung.

Among the Gasteropoda, *Carinaropsis*, *Cyclora* and *Microceras* pass up into the Hudson River, and *Conchopeltis* is peculiar to it.

Among the Cephalopoda, *Trocholites* passes into the Hudson River.

Among the Lamellibranchiata, *Pterinea* and *Cypricardinia* pass up to the Carboniferous; *Cleidophorus* to the Niagara; and *Matheria* is peculiar to it.

Among the Annelida, *Cornulites* passes up to the Devonian.

Among the Crustacea, *Calymene* and *Dalmanites* pass up to the Devonian; *Acidaspis* and *Bronteus* to the Lower Helderberg; and *Trinucleus* and *Sphaerocoryphe* to the Hudson River.

Of the 67 genera thus enumerated as commencing their existence in this Group, 19 terminated in the Hudson River, 14 in the Upper Silurian, 13 in the Devonian, 5 in the Carboniferous, and the remaining

16 terminated their career within it. *Streptorhynchus filitextum*, *Asaphus gigas*, *Calymene callicephala*, *Rhynchonella capax*, and numerous other species, pass up into the Hudson River; while *Zygospira modesta*, and *Strophomena tenuistriata* pass on into the Upper Silurian.

The Utica Slate Group.—This Group was named from its exposure at Utica, New York, and was defined, in 1842, by both Lardner Vanuxem and Prof. Emmons. It extends from New Jersey, across the State of New York, into Vermont, and passing under Lake Champlain enters Canada, where it spreads over a large area to the north and east, and extends westerly from Lake Ontario to Lake Huron. It is throughout a dark colored slate, loaded with carbonaceous matter. It is interstratified with thin bands of limestone, and passes into the Trenton Group below by gradual interstratification. In some places the laminæ are coated with a thin film of anthracite, and in other places silicious slate occurs of red, green, brown and black colors. In New York it reaches a thickness of 250 feet; in Vermont, 100 feet; in Canada, 510 feet; and in Pennsylvania, 400 feet. It thins out westerly, and while it separates the Trenton and Hudson River Groups at Cincinnati, on the Ohio river, it has lost its character of a black slate, and is composed of blue calcareous shales and marls, with interstratified thin limestones, and apparently forms mere passage beds from the Trenton to the Hudson River Groups. The distribution of the genera which commence an existence in this group is as follows:

In the vegetable kingdom, *Cyathophycus* and *Discophycus* are peculiar to it.

Among the Brachiopoda, *Leptobolus* and *Schizocrania* pass up into the Hudson River. And among the Crustacea, *Plumulites* passes up into the Hudson River.

Of the five genera thus supposed to commence their existence in this group, two do not pass beyond it, and the other three become extinct in the Hudson River.

While many of the Trenton species pass through it, yet there are a number which are characteristic of it, among which is *Triarthrus becki*, a species that follows the group in its extended geographical distribution, and changes of character, but is not known in either older or younger strata.

The Hudson River Group.—This group was named from the exposure on Hudson river, in New York, and first defined, in 1842, by Lardner Vanuxem. In New York it consists of shales, shaly sandstones, sandstones, slates and thick-bedded grits. The slates and

shales are generally dark brown, blue and black, and the grits gray, greenish and bluish gray. They are stratified and conformable, alternating a great many times without any regular order of alternation. The thickness is about 800 feet. It has a wide geographical distribution in Canada, and reaches a thickness of 2,000 feet. In the Lake Huron region it consists of a bluish or greenish colored argillaceous shale, holding thin beds of dark blue argillaceous, yellow-weathering sandstone; near the top there are marls, which are red, green, or a mixture of both; they hold very thin beds of dark bluish argillaceous limestone, the whole being surmounted by beds of gray or bluish arenaceous limestone. The thickness on Grand Manitoulin Island is 200 feet. In Ohio, Indiana and Kentucky, it consists of irregularly alternating layers of calcareous shale, marl and limestone. The thickness is about 800 feet, and the upper part is extremely fossiliferous. It occurs in Pennsylvania, Virginia, Tennessee, Missouri, Iowa, Texas, and New Mexico, and may be regarded as a universal group, though its petrological characters change, essentially, at distant localities.

The fossils are, usually, remarkably well preserved and abundant, and we are, therefore, frequently able to identify species that commenced an existence in earlier groups. There are many peculiar tracks found on the indurated shales supposed to have been made by Gasteropoda, Cephalopoda and Trilobites that have received such generic names as *Asaphoidichnus*, *Trachomatichnus*, *Teratichnus*, *Petalichnus*, *Ormathichnus*, and *Sœrichnites*.

The distribution of the other genera supposed to have commenced their existence in this group is as follows:

In the vegetable kingdom, *Blastophycus*, *Heliophycus*, *Dystactophycus*, *Dactylophycus*, *Trichophycus*, and *Sphenothallus*, are peculiar to it.

Among the Protista, *Microspongia* is peculiar to it.

Among the Polypi, *Fistulipora*, *Zaphrentis*, and *Favosites* pass up to the Carboniferous; *Alveolites* to the Devonian; *Halysites*, *Heliolites*, and *Sarcinula* to the Niagara; *Favistella* to the Clinton; and *Megalograptus*, *Dicranograptus*, and *Columnopora* are peculiar to it.

Among the Echinodermata, *Protaster* passes up to the Keokuk Group of the Subcarboniferous; *Anomalocystites* to the Oriskany; *Lepadocrinus* to the Lower Helderberg; *Hemicystites* to the Niagara; and *Anomalocrinus*, and *Xenocrinus* are peculiar to it.

Among the Bryozoa, *Cyclopora* and *Trematopora* to the Subcarboniferous.

Among the Brachiopoda, *Trematospira* to the Hamilton.

Among the Gasteropoda, *Phragmostoma* to the Hamilton.

Among the Cephalopoda, *Ascoceras* passes up to the Clinton.

Among the Lamellibranchiata, *Sedgwickia* and *Orthonota* pass to the Carboniferous; *Anodontopsis* to the Devonian; *Ischyrinia* to the Clinton; and *Anomalodonta*, *Cuneamya*, *Cycloconcha*, *Angellum* and *Orthodesma* are peculiar to it.

Among the supposed Annelida, *Spirorbis* extends to the Coal Measures; and *Nereidavus* and *Walcottia* are peculiar to it.

Among the Crustacea, *Cythere* passes up through the Coal Measures, and *Proetus* to the Carboniferous.

Of the 43 genera (without including tracks) thus enumerated, as commencing in this group, 19 do not pass beyond it; six become extinct in the Upper Silurian, five in the Devonian, and the remaining eleven pass up into the Carboniferous.

With this group, we close the Lower Silurian Formation, because we have here the greatest break, stratigraphically and palæontologically, that occurs from the base of the Potsdam to the top of the Lower Helderberg, and because it approaches nearer the line of division established by Murchison than any other thus far discovered. Wherever the Hudson River Group has been examined upon the continent, the superimposed rocks are unconformable with it, and no passage beds exist. In the western States the Niagara Group succeeds it. In the eastern States it is succeeded by the Medina and Clinton Groups before the Niagara is reached. On the Island of Anticosti, however, where the Hudson River Group has a thickness of 950 feet, it is succeeded by rocks resting conformably upon it, and with no apparent physical gap between them, although there is a sudden palæontological break. Of the 121 species known to Prof. Billings from this group, 80 suddenly disappear below the break, 41 only passing upward where they are as suddenly joined by 45 species unknown in the Lower Silurian strata. This hiatus or dividing line between the Lower and Upper Silurian will be more distinctly realized when we reflect, that from the Potsdam, out of 62 genera, 46 passed to higher groups, and 20 of these passed beyond this line, and yet, when all the genera from the Lower Silurian are considered, making 280, only 120 passed this line, notwithstanding the latter number came into existence in the Trenton, Utica Slate and Hudson River Groups, which are so intimately connected, and immediately precede this dividing line.

THE UPPER SILURIAN.

The Upper Silurian is subdivided into the Medina Group, Clinton Group, Niagara Group, Onondaga Salt Group, Guelph Group, and Lower Helderberg Group.

The Medina Group.—This group includes the Medina sandstone, Oneida conglomerate and Gray sandstone. It was named from Medina, New York.

The Medina sandstone was described by Vanuxem, in 1842, and redescribed by Hall, in 1843. It usually consists of red, marly or shaly sandstone, or variegated light-red and yellowish sandstone, and gray quartzose sandstone. In its geographical distribution it extends from New York into Canada, and as far west as Lake Huron, and from New York across Pennsylvania, Maryland, Virginia, and into Tennessee. Between the mouth of the Niagara river and Lewiston, it is 350 feet in thickness; at the west end of Lake Ontario, in Canada, 614 feet; on Lake Huron, 103 feet; and in Pennsylvania and Virginia, from 1,000 to 1,500 feet.

The Oneida conglomerate was defined, in 1843, by Prof. James Hall, as a quartzose conglomerate succeeding the Hudson River Group in the eastern part of New York, and a gray sandstone in the western part. In 1842, Vanuxem described the gray sandstone, and showed that it is intimately connected with the Medina sandstone. Its thickness in the region of Lake Ontario is less than 100 feet, but it extends southwardly increasing in thickness in Pennsylvania and Virginia, so that its maximum thickness in the latter States is not less than 700 feet. This thickness is included in the statement above of the thickness of the Medina Group. The character of the conglomerate is such that it indicates rapid deposition, and it is almost non-fossiliferous, though a few fragments of fucoids and shells too imperfect for definition have been found in it. The conglomerate and gray sandstone are included in the Medina Group, because the gray sandstone, in some places, graduates into the Medina so that they can scarcely be distinguished, except by the color, and for the still stronger reason that there are no fossils to characterize it.

The accumulation of the deposits, in this group, seems to have been more or less affected by waves and currents, and probably where it has its greatest thickness, took place with some rapidity. The most that can be said of it is, that it indicates a vast and important chasm in geological time. The fossils are usually very poorly preserved.

The only genera commencing an existence in this group are *Arthro-*

phycus, which is peculiar to it; and *Dictyophyton*, which continues as high as the Chemung.

The Clinton Group.—This group was named from the town of Clinton, in Oneida county, New York, and was very fully defined by Vanuxem, in 1842. It consists of green and black-blue shale, greenish and gray sandstone, red sandstone often laminated, calcareous sandstone and red fossiliferous iron ore beds. It has an extensive geographical distribution in the region of the Appalachian chain, and thins from it rapidly westward. In its extension north and south, it reaches from Georgia and Tennessee into Canada, and in its extension east and west, from Newfoundland to the Lake Superior region, though it does not appear in Indiana and Illinois. The thickness in the Lake Superior region is less than 50 feet; at Hamilton, Canada, 136 feet; and in New York, about 400 feet. It increases southerly until it reaches, as is supposed, in Pennsylvania, a thickness of 1,600 feet. In Newfoundland, where it is not clearly separable from the Niagara, both together have a thickness of 2,800 feet. In Georgia and Tennessee the thickness is about 400 feet. In some places the Medina so graduates into it that the line of separation is hardly determinable, and at other places it becomes very intimately blended with the Niagara Group.

The distribution of the genera supposed to have commenced an existence in this group is as follows:

In the vegetable kingdom, *Ichnophycus* is peculiar to it.

Among the Polypi, *Acervularia*, *Chonophyllum*, and *Cyathophyllum* extend to the Carboniferous; *Eridophyllum*, *Ptychophyllum*, *Cystiphyllum*, and *Strombodes*, extend up into the Devonian; *Cannopora*, and *Omphyma*, occur in the Niagara Group, and *Cyclolites* is peculiar to it.

Among the Echinodermata, *Ichthyocrinus* occurs as high as the Burlington Group; *Caryocrinus* occurs in the Niagara; and *Closterocrinus* is peculiar to it.

Among the Bryozoa, *Rhinopora* and *Helopora* occur in the Niagara.

Among the Brachiopoda, *Chonetes* extends to the Permian; *Meristella* and *Pentamerus* to the Hamilton; *Strophodonta* to the Chemung; and *Leptocœlia* to the Upper Helderberg.

Among the Cephalopoda *Discosorus* and *Huronia* extend to the Niagara; and *Glossoceras* is peculiar to it.

Among the Lamellibranchiata, *Pyrenomœus* is peculiar to it.

Among the Crustacea, *Phacops* and *Homalonotus* extend to the Upper Devonian.

Of the twenty-seven genera thus enumerated as commencing in this group, five did not pass beyond it, seven became extinct in the Niagara, ten in the Devonian, and five passed up into the Carboniferous.

Pentamerus oblongus, *Spirifera radiata*, *Meristella cylindrica*, *Lingula lamellata*, *Caryocrinus ornatus*, and many other species pass from the Clinton to the Niagara, so that the groups are strongly connected specifically, as well as graduating into each other.

The Niagara Group.—This group was so named from its development at Niagara Falls. It was defined by Vanuxem, in 1842, and more fully by Hall, in 1843. It consists of limestones and shales, and sometimes sandstones, though changing its lithological characters and combinations in different and distant localities. It is one of the universal groups.

In New York and the southern part of Canada, its thickness is from 250 to 300 feet, on Grand Manitoulin Island, 560 feet; on Cockburn Island, 400 feet; in the Lake Superior region, 300 feet; in Ohio, Indiana, Illinois and Iowa, about 600 feet; and in Missouri about 200 feet. Its greatest thickness, however, is in Tennessee or Newfoundland, but the measurements that have been made at these places have left the exact thickness uncertain.

It is so well characterized by its fossils, that there is, usually, no difficulty in determining it at any locality, nothwithstanding any change that may have taken place in its petrological characters.

The distribution of the genera supposed to have commenced their career in this group, is as follows:

Among the plants, *Psilophyton* extends to the Devonian, and *Glyptodendron* is peculiar to it.

Among the Protista, *Astræospongia* extends to the Hamilton; and *Aulocopina* and *Palæomanon* are peculiar to it.

Among the Polypi, *Amplexus*, *Cyathaxonia*, and *Syringopora* pass up into the Coal Measures; *Striatopora* to the Burlington; *Anthophyllum*, *Blothrophyllum*, *Cladopora*, *Diphyphyllum*, *Limaria*, *Lyellia*, *Thecia*, *Thecostegites*, and *Vermipora* pass up into the Devonian; *Calceola* to the Lower Helderberg; *Baryphyllum* to the Onondaga Salt Group; and *Acanthograptus*, *Astræophyllum*, *Calophyllum*, *Calyptograptus*, *Cœnites*, *Cystostylus*, *Dictyostroma*, *Ethmophyllum*, *Inocaulis*, *Plasmopora*, *Rhizograptus*, *Syringolites*, *Strephodes*, and *Vesicularia* are peculiar to it.

Among the Echinodermata, *Cyathocrinus* and *Poteriocrinus* extend to the Coal Measures; *Actinocrinus* to the St. Louis Group;

Platycrinus to the Kaskaskia; *Calceocrinus* and *Melocrinus* to the Warsaw; *Codaster* to the Burlington; *Apiocystites*, *Ampheristocrinus*, *Callocystites*, *Coccocrinus*, *Crinocystites*, *Cystocrinus*, *Echinocystites*, *Eucalyptocrinus*, *Glyptaster*, *Gomphocystites*, *Hemicosmites*, *Heterocystites*, *Holocystites*, *Lampterocrinus*, *Lyriocrinus*, *Macrostylocrinus*, *Myelodactylus*, *Pisocrinus*, *Saccocrinus*, *Sphærocystites* and *Stephanocrinus* are peculiar to it.

Among the Bryozoa, *Polypora* extends to the Coal Measures; *Callopora* to the Keokuk; *Hemitrypa* and *Paleschara* to the Lower Helderberg; and *Hornera*, *Lichenalia*, *Sagenella*, and *Thamniscus* are peculiar to it.

Among the Brachiopoda, *Spirifera* passes to the Jurassic; *Athyris* to the Coal Measures; *Centronella*, *Cyrtina* and *Nucleospira* to the Subcarboniferous; *Coelospira* to the Corniferous; *Anastrophia* and *Rhynchospira* to the Lower Helderberg; *Monomerella* and *Trimerella* to the Guelph; and *Cyrtia*, *Meristina* and *Skenidium* are peculiar to it.

Among the Gasteropoda, *Platystoma* extends to the Coal Measures; *Strophostylus* to the Upper Helderberg; and *Tremanotus* is peculiar to it.

Among the Cephalopoda, *Streptoceras* is peculiar to it.

Among the Lamellibranchiata, *Goniophora* extends to the Chemung; *Megalamus* to the Guelph; and *Amphicœlia* and *Palæocardia* are peculiar to it.

Among the Crustacea, *Cyphaspis* is peculiar to it.

Of the 90 genera thus supposed to have commenced an existence in this group, 49 never passed beyond it, 8 became extinct in higher groups of the Upper Silurian, 13 became extinct in the Devonian, and 20 passed into the Carboniferous or beyond.

This group is remarkable for the abundance of its fossils, and for the appearance of such a large number of new genera, as well as for the exceedingly great proportion that became extinct within it. It is really the only universal group in the Upper Silurian, and, therefore, constitutes the great body of it, for the groups which succeed in this formation are quite local in distribution, in comparison.

The Onondaga Salt Group.—This group is limited in its geographical distribution, though it occurs in Pennsylvania, and extends from New York into Canada, and thence northwestwardly to Lake Huron, Mackinac, and the Lake Superior region. It was named from Onondaga county, New York, and was defined by Vanuxem, in 1842, and further defined by Hall, in 1843. It consists, usually, of marls and thin shaly

limestones containing salt and gypsum. In Wayne county, New York, it has a thickness of 1,000 feet, but about Grand river, in Canada, it is reduced to 300 feet; about Mackinac, to 40 feet; and in the Lake Superior region, to less than 50 feet.

It is not very fossiliferous, and only three genera are known to have commenced their existence in it, viz: *Eurypterus* which passed up as high as the Coal Measures, *Pleurodictyum* which occurs in the Lower Helderberg, and *Eusarcus* which is peculiar to it. It was called the "Onondaga Formation," by the Canadian Geologist, in 1863, and it is an improvement to drop the word "salt," and call it simply the Onondaga Group.

The Guelph Group.—The Niagara Group is succeeded in western Canada by a lenticular mass, having a maximum thickness of about 160 feet, which was defined by Sir Wm. Logan, in 1863, as the Guelph Group, from the town of Guelph, where it is well exposed. It is a limestone dolomite, and may have been a brackish water deposit. It is particularly distinguished by the total absence of the remains of the Echinodermata. It contains many species peculiar to it, but is not characterized by the appearance of any new genera.

The Lower Helderberg Group.—This group was named from the Helderberg mountains, in New York, and was defined by Hall, in 1859. It is composed of a series of limestone strata, and has an extensive distribution in the eastern part of the continent. It is 500 feet thick in New York, and extending eastwardly it reaches its greatest development at Gaspe, Canada, where it is 2,000 feet in thickness. It occurs in Maine and in Pennsylvania, where it is 1,700 feet in thickness, and in Tennessee where it is only 100 feet thick.

The distribution of the genera, which are supposed to have commenced an existence in this group, is as follows:

Among the plants, *Annularia* extends to the Coal Measures.

Among the Polypi, *Sphærolites* is peculiar to it.

Among the Echinodermata, *Edriocrinus* extends to the Upper Helderberg; *Aspidocrinus*, *Brachiocrinus*, *Coronocrinus*, *Dictyocrinus*, *Mariacrinus*, and *Sphærocystites* are peculiar to it.

Among the Bryozoa, *Ichthyorachis* is peculiar to it.

Among the Brachiopoda, *Eatonia*, *Merista* and *Rensselæria* extend up into the Devonian, and *Camarium* is peculiar to it.

Among the Lamellibranchiata, *Mytilarca* extends to the Subcarboniferous; *Megambonia* and *Ilionia* to the Upper Helderberg, and *Peteronitella* is peculiar to it.

Among the Crustacea, *Dolichopterus* extends to the Coal Measures, and *Pterygotus* is peculiar to it.

Of the twenty genera that commenced an existence in this group, eleven never passed beyond it, three are known in the succeeding group of the Lower Devonian, three became extinct in higher groups of the Devonian, and the other three passed up into the Carboniferous.

With this group we close the Upper Silurian, because we have here another great stratigraphical and palæontological break, and because we have arrived, as near as can be determined, at the top of the formation as established by Murchison. Out of 141 genera that commenced an existence in this formation, 82 became extinct within it, or a much larger proportion than became extinct among the genera that arose in the Lower Silurian. The palæontological chasm is, therefore, wider between the Upper Silurian and the Devonian than it is between the Lower and Upper Silurian.

In conclusion, it may be proper to remark, that among the genera from these formations there may be a few synonyms, and while numerous species will be added to the 3,560 that have been described, it is not probable that many genera will be added to those mentioned. I am not prepared to draw the comparison between the groups which have been thus established, in North America, and those within the same formations in Europe and other countries, because this must be done after great study of the variable specific characters, and an exhaustive comparison of the species. If, however, I have broken the ice, in this regard, and furnished any assistance to others by calling attention to the distribution of the genera, it is all that can be expected.

THE PREHISTORIC MONUMENTS OF ANDERSON TOWNSHIP, HAMILTON COUNTY, OHIO.

By Charles L. Metz, M.D.

Anderson township is situated in the southeastern portion of Hamilton county, the Ohio river forming its southern and southwestern, and the Little Miami its northern and western boundaries; at a point near the junction of the two rivers is the village of California. The general surface or plain of the township, is elevated about six hundred feet or more above the Ohio, and broken up by deep ravines, especially on its southern and western borders. Whilst along the course of the Ohio, the

township presents an almost precipitous front, the slopes bordering the Little Miami are much less abrupt, receding gradually for a half mile to a mile from the stream. A plain of rich alluvial or bottom land varying from one eighth to three quarters of a mile in width, occupies a position between the bluffs and the rivers. Jutting out from the hills or bluffs are plateaus, of drift gravel formation, having a range of elevation of from thirty to one hundred feet above the first bottom of the river. On these elevated plains along the course of the Little Miami river, the Prehistoric Monuments are found in greatest number.

In the northeastern portion of the township, located on a level plateau, elevated about one hundred feet above the Little Miami river, and in surveys Nos. 1775 and 1575, is an interesting group of earthworks. Of this group several of the most prominent were described in a former paper, entitled the "Prehistoric Monuments of the Little Miami Valley,"* and designated as Group D on the accompanying chart. Since the time of the publication of the above mentioned paper, many additional works have been discovered. In the present paper, I shall continue the same enumeration as in the former, and designate this Group D accordingly, so as to avoid confusion.

No. 1 of this group is the largest and most important earthwork in this portion of the valley. It is located on an elevated ridge, about four hundred yards west of Mr. Michael Turner's residence. It consists of a circular embankment, inclosing an area of about four acres. This embankment has a gateway to the southeast thirty-six yards wide; leading from this gateway is a causeway one hundred feet wide, and extending three hundred feet. A mound five and a half feet high is located just within the gateway. An interesting description of this work by Col. Chas. Whittlesey, was published in *Smithsonian Contributions*, Vol. iii., Art. 7, May, 1850;† and in a paper entitled "The Antiquities of the Miami Valley," *Cincinnati Chronicle*, November, 1839, by T. C. Day, Esq. Col. Whittlesey erroneously located this work in Clermont county, whereas it is situated in Hamilton. No. 2 on chart is a circular embankment, having a diameter of about one hundred and twenty-five yards. The material for its construction was evidently taken from within the inclosure. The level of the inclosed area being from eighteen to twenty-four inches lower than the general plain on which the work is located. The work has a gateway about forty feet wide to

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* *Vide* This Journal, Vol. i., No. 3, Oct., 1878.

† See supplementary plan, by Col. Charles Whittlesey, on chart.

the southeast. The embankment has an elevation averaging two feet. The plain immediately west of this circle is the site of an ancient cemetery, human remains having been found at a depth of two feet; the interments, as far as known to the writer, being in the horizontal position. The extent of this cemetery is about two acres. Nos. 3, 4 and 9 of this group are a chain of mounds ranging from southwest to northeast. They are two hundred yards south of work No. 2, and on the same level. The largest of these mounds (No. 3) has an elevation of twelve feet, and a circumference at base of about two hundred and fifty feet. The next, No. 4, has an elevation of five feet, circumference at base one hundred and fifty feet. Mound No. 9 is about three feet high, and has a base about the same dimensions as No. 4. Mound No. 5 is located about four hundred feet east of work No. 2, and in a field annually cultivated, it is of very regular shape, and has an elevation of three feet, with a circumference at base of one hundred and fifty feet. Mound No. 10 is situated on the same plain, and three hundred feet east of No 5, elevation five feet, circumference at base one hundred and fifty feet.

On the lands of Mr. Gano Martin can be traced two parallel lines of embankment. (Group D, No. 11 on chart) extending E.N.E. for about three quarters of a mile. These parallels are about two hundred feet apart, and where they are protected by the fence lines, are about eighteen inches in height, and from ten to twenty feet in diameter. They formerly, I am told, terminated in a small circle, the site of which is occupied by the residence of Mr. Martin. They evidently had some connection with the interesting work on the lands of Mr. Turner, described by Col. Whittlesey and others previously referred to. The next group—

GROUP C

Is located on the first and second plain along the line of the Cincinnati & Eastern Railway, and the line of the Batavia turnpike, on surveys Nos. 427, 500, 65, 32, 567 and 624, and in the vicinity of the village of Newtown. No. 1 of this group, a mound, is located on the west bank of Dry run, just north of the Batavia turnpike crossing. Its elevation is about eight feet, diameter at base about eighty feet.

Mounds Nos. 2, 3 and 4 are located on the second plain of the river, which has here an elevation ranging from forty to sixty feet. Nos. 2 and 3 are about two feet higher respectively, are annually cultivated, and will before long become entirely obliterated from that cause.

Mound No. 4, the largest of the three mounds, has an elevation of ten feet, and at base a circumference of two hundred and fifty feet. It is well preserved, and has a beech tree growing on its eastern slope. These mounds are about two hundred feet apart, and range westwardly.

No. 13 of this group is located on the northeastern portion of this plain. It consists of a circular embankment about one hundred feet in diameter. This work is now almost entirely destroyed by the cut made through the edge of this plain for the New Richmond Railroad.

Mounds 5 and 6 are situated in a field south of the turnpike, on the same plain as Nos. 2, 3 and 4 on the lands of Mr. Abner Hahn, and are respectively five and three feet in height.

Mound No. 7 is known as the "big mound;" it is the largest in Hamilton county. A description by T. C. Day, published in the *Cincinnati Chronicle*, August, 1839, entitled "The Mounds or Tumuli of the Little Miami Valley," is as follows:

"About a mile east of Newtown, in this county, on the farm of Levi Martin, is a mound of the largest class. Its shape is an oval oblong, rounding to its apex with the most perfect accuracy. It is situated on a shelf of land about thirty feet above the alluvial bottom of the Little Miami river. The soil around is gravelly, but the material of its structure, as usual, is a brick clay. Near its summit is a large beech, probably two feet in diameter, and its sides are covered with a thick growth of underwood, with several large forest trees. It is within three hundred yards of a high range of hills, and could not, therefore, have been erected as a watch tower or a place of defence. It has never been opened, but the most probable conjecture is, that it is the monument of some mighty chief, who lies interred in its centre. The plain around its base is perfectly level, except within two hundred feet of what was probably its original circumference, the washings of the rains have filled up to a considerable height. The dimensions of this mound, from actual admeasurements, are as follows:

Circumference at base	600 feet.
Width at base	150 "
Length of, at base	250 "
Perpendicular height	40 "

Covering an area of an acre."

A recent measurement (July, 1878) by the writer, gave the height as thirty nine feet, circumference at base six hundred and twenty-five feet. Col. Chas. Whittlesey, in Vol. iii., *Smithsonian Contributions*, Art. 7, May, 1850, describes this mound, and figures it in Plate iii., No.

2. He has, however, erroneously described the mound as being located one mile north, instead of one mile east, of Newtown. Three hundred yards west of, and on the same plain as the big mound, is located mound No. 8 of this group. It is three feet in height, and at base has a circumference of one hundred and fifty feet. The asterisk directly north of this mound indicates the site of a mound that was entirely removed during the construction of the Batavia turnpike. Mound No. 9 is located east of the village of Newtown, in the center of the Odd Fellows' Cemetery, and on the higher portion of the first plain or bottom land. It is very symmetrical in shape, having an elevation of about ten feet, circumference at base two hundred and ten feet. A small mound (No. 14 on chart) three feet in height, is situated on the east side of the same inclosure.

An asterisk on the Plainville road, north of the village, marks the site of a mound recently removed. It was about seven feet in elevation. An account, by S. A. Bell, of its removal and contents was published in the *Cincinnati Gazette*, March 30, 1874, an extract from which is as follows:

"Mr. S. A. Bell, of Plainville, brought to our office, on Saturday, some pieces of wood almost carbonized into charcoal, a number of fragments of bones, evidently those of young children, and fragments of teeth, back and front, which must have belonged to the mouth of a child; and also a rodent animal's tooth, which had obviously been worn as a neck ornament. They were found last week under an ancient mound, which was removed for the purpose of building the approaches to the Newtown bridge. They lay in a large bed of coal and ashes, which already indicated that the fire had covered a space twenty-five feet in diameter. That it must have been a very hot and long continued conflagration, was evident by the hardness and color of the ground and remains which had been effected by the heat. When the fire had burned out, the coal and ashes had been raked together in a heap from four to ten inches in depth. From this heap the pieces of bone in the collection shown to us have been picked out. Among the discoveries were a skull which had escaped complete combustion, but had been flattened down by the weight of the dirt above it, leaving its character plain and distinct, however; close beside it lay three front and four jaw teeth, seemingly unaffected by fire. Most of the other bones lay promiscuously among the ashes. The number of victims was evidently large, and (the remains) were all those of children."

Two hundred yards northwest from the site of the mound just de-

scribed, and within a small private burial inclosure is a small mound (No. 15 on chart), it has a diameter of forty feet at base, and an elevation of about three feet. An asterisk near the junction of the two turnpikes, in Newtown, shows the site of a mound removed previous to 1830; five skeletons were found with their heads toward the center of the mound in a circle. An asterisk in the center of the village marks the site of a mound removed about the same time as the former one just described. Of this mound, Mr. Wm. Edwards, who is one of the oldest residents, and a most intelligent and reliable observer, says: "The hands in the Newtown district were working on the road, when it became necessary to remove a small mound in front of Mr. Dunseth's house, in Newtown, where they found five skeletons, and a pot, apparently formed of mussel shells, and a kind of glutinous cement. It would probably have held a gallon, and was perfectly formed in shape. It was found in the center of the mound, and the skeletons lying regularly around it, with their heads toward it as a common center. Several other mounds have been removed where the skeletons have been placed in the same positions."

Immediately to the south of Newtown is an elevated plateau, about four hundred yards wide, extending to a small stream called Jennie's run, which flows along its southern base. This plain is elevated about eighty feet above the level on which the village is located. It is of drift gravel formation, and extends westward about a half mile. About the centre of this elevated plain, and on its northern edge, a mound (No. 16, Group C) is located. This mound is truncated, having graded ways extending to the top of the mound, from the north and south sides. It has an elevation of ten feet, and a diameter from east to west of sixty feet. On the southern edge and slope of this plateau, and in a line with this mound, a great number of skeletons were discovered and exhumed in the summer of 1838. Of this discovery, Mr. T. C. Day, an enthusiastic archæologist of that time, writes: "Last summer, the workmen, in procuring gravel for the Batavia turnpike, immediately in the rear of Newtown, in the bank of a small stream called Jennie's run, disinterred an immense number of human skeletons. This ancient burial ground is on a gravelly point that juts out from the bank into the run, forming an acute bend. The graves are not, on an average, more than two feet in depth, though probably they were a great deal deeper, as the ridge has evidently washed to a considerable degree. As far as caved, the point is a solid body of coarse gravel, till within about two and a half feet of the surface, which is

composed of sand and loam. The skeletons lay in the sandy stratum between the gravel and earth, and so far as preservation is concerned, it has answered the purpose well. Whole anatomies have been exhumed in an excellent state of soundness, the teeth particularly, some of them as white as ivory, and perfect in every respect. Forest trees, such as beech, sugar, and oak, some at least two feet in diameter, were growing immediately over the graves, and their gnarled roots twisted fantastically through the skulls of these remnants of an ancient people. A fall of gravel would frequently leave bare the whole front of a grinning skeleton, seemingly thrust in the grave, feet foremost, and in fact the whole of the bodies bore evidence of a promiscuous burial, some placed horizontally, facing the west, others level, anon a group of four heads within a space of two feet, and in every imaginable position. About twenty feet from the first discovery of the bones, the workmen came to a large body of charcoal, and the remains of a stone fire place. An earthen vessel was found by some boys, which was broken and destroyed before an actual description could be obtained. Several of the skulls exhibited traces of violence, such as would lead one to suppose that this had been a scene of carnage, and the dead bodies thus furnished a rude and hasty burial."

Mr. Wm. Edwards visited the grounds during the time that the excavations were being made, in company with Mr. Day, the writer of the above extract, and verifies all he says as true; he also further states that there were a large number of bodies exposed during the grading of the road; and since that time curiosity has led a great many people to visit the place and dig for bones. Mr. Day and himself went to the bank and dug out the four skeletons, fire place, and charcoal, as described above. Mound No. 11 is located on the east side of the road, leading from Newtown to Clough creek, and three quarters of a mile south of the village. It has an elevation of fifteen feet, and a circumference at base of two hundred and twenty-five feet. This mound was designated in a former paper* as the Jewett mound. On the same road, and about one half mile further to the south of this mound (No. 11), located on the third plateau or dividing ridge between Jennie's run and the Clough creek, is an oblong mound (No. 17, Group C) eight feet high and one hundred and twenty-five feet in length from north to south. Four hundred yards northwest from the west end of the village of Newtown, on the lands of Mr. A. Hahn, is the site of an ancient

* This JOURNAL, vol. i., p. 125.

village or camp (No. 18, Group C); it occupies the more elevated portion of the first bottom of the Little Miami river. Here numerous flints, arrow heads, pipes, fleshers, potsherds, animal remains, together with charcoal and ashes, are turned up by the plow. On the still higher portions of this plain several human skeletons have been discovered interred horizontally (No. 19, Group C). During the course of the present month (October, 1881), a small pit was dug immediately west of the house. At the depth of 3 feet a skeleton was found horizontally interred. Two and a half miles northeast of the village, on the Newtown and Milford road, is a tongue of land extending out from the second plain of the river, having an average height of about sixty feet, and a width of from one hundred to three hundred yards. It is located in survey 427, on the lands of Mr. Samuel Edwards, and is the ridge on which the residence is situated. The extreme northern point of this ridge is occupied by an ancient cemetery (No. 20, Group C). It has not been sufficiently explored to determine the position of the inhumations. Two hundred yards south of this cemetery, on the same point of land, are two mounds (Nos. 21 and 22, Group C), the former being four feet high, and having a diameter of 50 feet north and south. No. 22, the larger mound, has an elevation of eight feet, and measures, at base, two hundred and fifty feet in circumference. These mounds are three hundred feet apart in a line east and west, and about three hundred yards north from the residence of Mr. Edwards. Two hundred yards northeast of the residence of Mr. Edwards, and on the same plateau is located a circular embankment inclosing a mound (No. 23, Group C). The work is a perfect circle, except on the southeast, where it is interrupted by a gateway about fifty feet wide. The circumference of the work is about seven hundred feet. The mound is of an oblong shape, and three and a half feet high. The embankment is about two feet in elevation, and the material for its construction seems to have been taken from within the inclosure, forming a slight ditch.

Mound No. 24 of this group is located on a spur of land about one hundred and fifty feet above the level of Dry run, about three hundred yards southeast from the Dry run bridge, and south from the Batavia turnpike. It is composed entirely of flat limestones, of various sizes and thicknesses, and covered with about two feet of clayey loam. It is nine feet in elevation, and has a diameter at base from east to west of sixty feet. It has been opened in its center to a depth of five feet; a layer of charcoal and ashes was reached when the work was discontinued.

Mound No. 25 is located on the lands of Mr. L. S. Durham, in the southwest corner of survey 1,126. It is three and one half feet high, and 60 feet in diameter at base; being situated on the edge of an ele vated plateau, it commands an extensive view. On the lands of Mr. M. Lawyer, in survey 624, and about 200 yards northeast from the residence, is an ancient village site (No. 26, Group C) of probably 4 acres. In addition to several fine barbed arrow points found by the writer at the time of his visit to this locality, a circular disk of bone was found, which proved to be made from a human cranium, probably from one of the parietal bones. Sherds of pottery, flint chips, ashes and charcoal, were also noticed. The extent of the village or camp could be readily determined by the area of black rich soil, contrasting with the surrounding light clayey loam.

GROUP E.

Group E is located principally in the vicinity of the Turpin homestead, a quarter of a mile east of the Union bridge, and about two miles west of Newtown. Mound No. 1 of this group is situated north of the Batavia turnpike, and immediately in front of the Turpin residence, on the second plain of the Little Miami river. It has an elevation of about ten feet, diameter at base of about fifty feet. This mound has been considerably reduced in size, its shape being at first oblong; subsequently the ends were removed to make it circular. At that time a large stone pipe representing a frog was found, which is now in the collection of Philip Turpin, Esq. The plain west of the house has long been a resort for relic hunters; here are found on the surface, potsherds, flints, arrow heads, pot-stones, fleshers, axes, disks, pipes, etc. This level evidently was the site of an ancient village or place of industry (No. 2, Group E). Mr. Edwards informs me that at the time of digging the cellar for the Turpin house, fifty skeletons were removed, besides several curiosities, such as stone pipes of various sizes and shapes. One of the pipes had a bird's wing beautifully carved on both sides. In setting fence posts along the level where the house stands, they came upon human bones very frequently. The interments were generally in horizontal positions. East of the house, and where the barn now stands, was a small mound, which was about three feet high,—an asterisk on chart marks the site.

South of the turnpike, and east of the Clough creek road, located on the top of the dividing ridge between the Little Miami river and the Clough creek, is a mound (No. 3, Group E) three feet high, and

having a diameter at base of sixty feet. The level east of this mound is known to be an ancient cemetery, the interments being as far as noted in the horizontal position, and under flat limestones; west of the Clough road, on the same level numerous flint and stone implements, potsherds, animal remains, and occasionally human remains are turned up by the plow. The soil is here very dark in color for an area of two acres in extent, whilst the surrounding surface is of a peculiar gravelly reddish loam. Westward from the Union Bridge is a ridge of land, known as the sand ridge, that forms a series of elevated plateaus, as it extends westwardly for about a mile, and reaches an elevation of over six hundred feet above the first plain. Its greatest width is about three hundred yards. After an almost abrupt ascent of about one hundred and twenty-five feet, the second level or bench is reached, having an area of probably 4 acres. This level is undoubtedly the location of an ancient cemetery (No. 4, Group E). On the surface, numerous potsherds, together with human bones, are found. Many fine relics have been obtained by the writer and others from this locality. Crossing the level another steep ascent of about one hundred feet brings us to the third plain. In the centre of the upper edge of this plain or bench, overlooking the cemetery, was, until recently, a circle of upright stones, ten feet in diameter (No. 5, Group E). These stones were from ten to twelve inches wide, and from four to five feet in length, arranged close together, and forming a circle. From this point the ascent is gradual until the highest point is reached, about six hundred feet above the Little Miami river. Over this entire slope, broken bowlders, flint chips, fragments of pottery, arrow flints, stone implements, etc., are found giving evidence of a long and continued occupation. On the lands of Mrs. Williams, on the east side of the Ohio turnpike, surrounded by forest trees, is a mound (No. 6, Group E) eight feet high, with a circumference of two hundred and twenty-five feet at its base. Three hundred yards farther to the south, on the still more elevated lands of Mr. Jacob Betz, located on the east side of the turnpike, and just on the north corporation line of the village of Mt. Washington, is a mound (No. 7, Group E) having a diameter of one hundred feet at base, and an elevation of twelve feet. An extensive view of the Ohio river and Clough creek valleys is obtained from the summit of this mound. East of the village of Mt. Washington, on the road leading from that village to Clough creek, is a mound (No. 8, Group E) located on an elevated ridge overlooking the valley of the creek. This mound is on the lands of Mr. Leiser, and is six feet

high, and sixty feet in diameter at base. It is one of a line of mounds extending from the Ohio river to Newtown, and across Hamilton county to the Mill Creek valley, and thence up this valley to Hamilton in Butler county. Through the Clough valley seems to have been the course of a great trail or highway, leading from the Little Miami valley to a point on the Ohio river, about where the village of Palestine, in Clermont county, is situated, and along this route many isolated graves, burials under stone heaps, and beds of charred wood and ashes are discovered. On the Henry Brachman estate, near Cedar Point station, on the Cincinnati & Portsmouth R. R., is a mound three and a half feet high, and 40 feet in diameter; it is situated in a field annually cultivated.

GROUP F.

Is situated principally on the summit of the high hills above the town of California, on the Ohio river, and north of the New Richmond turnpike. No. 1 of this group is a mound located on the second bottom of the Ohio, near the junction of the Ohio and Little Miami rivers, on the lands of Mr. Ebersole. It has an elevation of fully seven feet, and is about two hundred and fifty feet in circumference at base. The level north of the mound, and extending to the Cincinnati and Richmond turnpike, is an ancient cemetery (No. 2, Group F). The burials are under flat slabs of limestone, and are discovered two feet from the surface. About thirteen skeletons have been unearthed by the plow, but as yet no systematic exploration has been made. In survey No. 397, on the Whetstone estate, located on the summit of a high bluff commanding a most extensive view up and down the Ohio river, is a mound (No. 3, Group F) constructed of flat slabs of imestone of various sizes; the greater portion of the stone visible show evidences of the action of fire. It has an elevation of five and one half feet, and a diameter at base of fifty feet. The point on which this mound is situated has an elevation of about six hundred feet above low-water mark of the Ohio river.

Directly to the east of this point, and separated from it by a deep ravine, is a cresent-shaped ridge, known as the Hawkins ridge, having an elevation of about six hundred feet above the river. Immediately on the crest of the hill, and overlooking the Ohio river, are five mounds (No. 4, Group F) forming a continuous chain, extending from east to west over two hundred feet. They are five feet high, and have a diameter north and south of about fifty feet. At the time of my visit,

the mound farthest east had been excavated at its center, and several fragments of a human skeleton, together with a few fragments of burnt limestone were found in the earth thrown out. From the summit of these mounds a view can be had ranging over half of the county, the mounds on Linwood and Norwood heights, respectively, five and seven miles distant, being in plain sight. The point commands the river for miles in both directions. Fifty yards northeast from these mounds, on the same ridge, is located a mound (No. 5, Group F) having an elevation of six feet, and a diameter at base of sixty feet; on its western slope an oak tree five feet in diameter is growing. Two hundred yards northward from this last mound, was located a mound about five and one half feet high, which was removed to make way for the Hawkins' residence. In the course of the removal of the mound, a skeleton was found at its base in a horizontal position, under a layer of charcoal and ashes; the bones showed no indication of the action of fire. In the cranium of this skeleton, a triangular flint arrow point was found imbedded. The site of the mound is marked on the chart by an asterisk. Northeastward from this ridge, in survey 620, on the lands of Mr. Crotty, located on the crest of a hill, is an oblong shaped mound (No. 6, Group F), having an elevation of eight feet, a diameter of seventy-five feet, and a length of one hundred and twenty-five feet. It commands a view of the Ohio and Little Miami rivers. About four hundred yards northeast from this mound, on the lands of Mr. S. W. Markley, and about three hundred yards west of his residence, is probably the site of an ancient village (No. 7, Group F) covering an area of about two acres. The usual indications, such as fragments of pottery, flint, chips, animal remains, etc., are plowed up. In the northern portion of survey No. 585, on the lands of J. W. Markley, located on a hill top, is a mound three and one half feet high, and having a diameter at base of forty feet (No. 7, Group F). Continuing to the eastward until we reach the lands of Mr. J. Mathews, we find on a level hill top the usual evidence indicating its former continued occupation as a camp or village (No. 8, Group F).

GROUP G.

This group occupies the southeastern portion of the township. On the lands of the estate of J. A. G. Morton, in survey 1679, on a bluff point just north of the New Richmond turnpike, is an ancient burial place (No. 1, group G). The method of inhumation seems to have been in the horizontal position as far as yet determined. The level

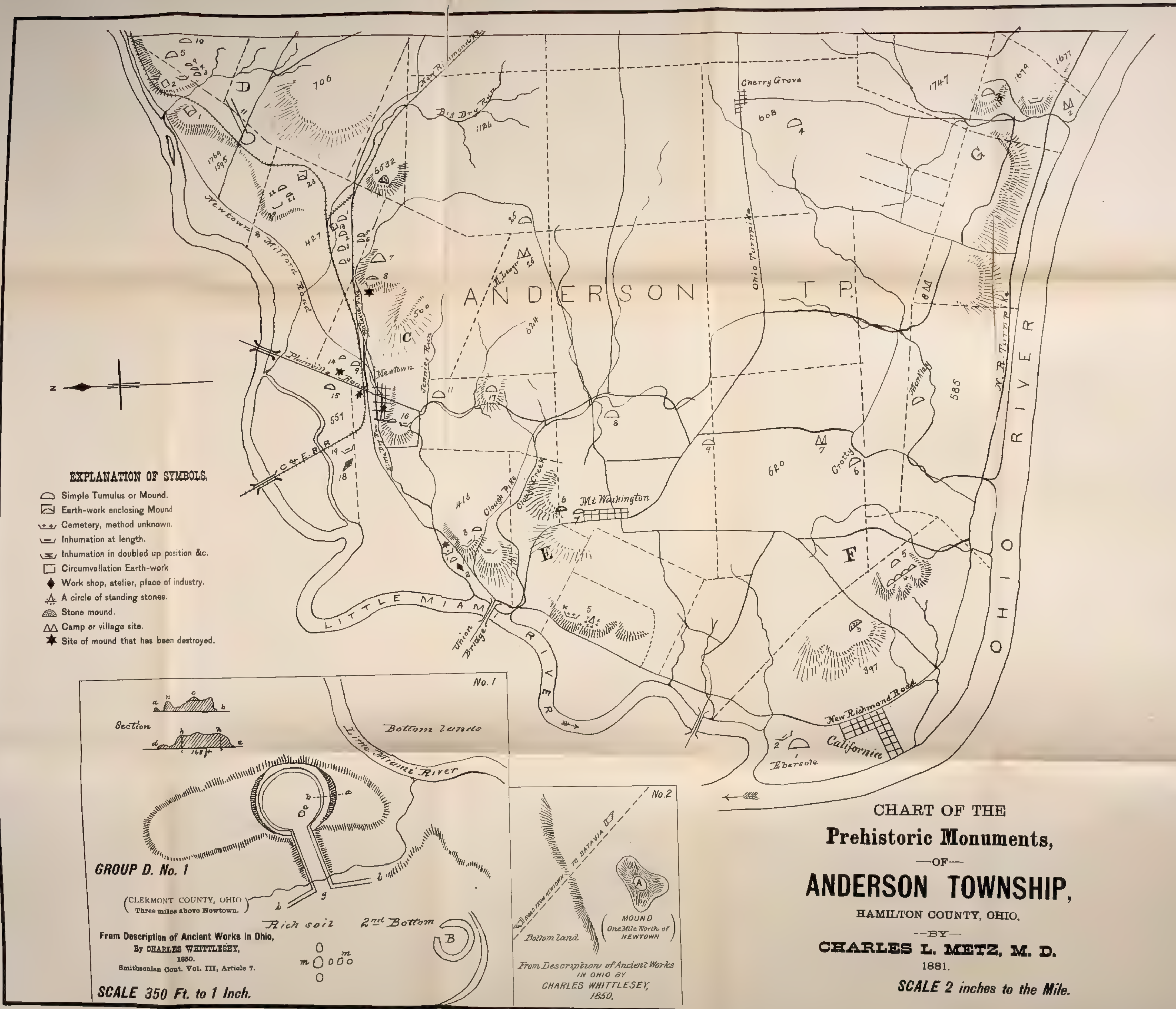
CHART OF THE
Prehistoric Monuments,
—OF—
ANDERSON TOWNSHIP,
HAMILTON COUNTY, OHIO.
—BY—
CHARLES L. METZ, M. D.
1881.
SCALE 2 inches to the Mile.
EXPLANATION OF SYMBOLS.
Simple Tumulus or Mound.
Earth-work enclosing Mound
Cemetery, method unknown.
Inhumation at length.
Inhumation in doubled up position &c.
Circumvallation Earth-work
Work shop, atelier, place of industry.
A circle of standing stones.
Stone mound.
Camp or village site.
Site of mound that has been destroyed.
ANDERSON TP.
OHIO RIVER
LITTLE MIAMI RIVER
Newtown & Milford Road
Plainville Road
Newtown
New Richmond R.R.
Big Dry Run
Jennies Run
Clough Pike
Clough Creek
Mt Washington
Union Bridge
Ohio Turnpike
Cherry Grove
N. R. Turnpike
Crotty
Markley
New Richmond Road
California
Ebersole
C. & E. R.R.
No. 1
Section
Bottom lands
Little Miami River
Rich soil
2nd Bottom
GROUP D. No. 1
(CLERMONT COUNTY, OHIO
Three miles above Newtown.)
From Description of Ancient Works in Ohio,
By CHARLES WHITTLESEY,
1850.
Smithsonian Cont. Vol. III, Article 7.
SCALE 350 Ft. to 1 Inch.
No. 2
ROAD FROM NEWTOWN TO BATAVIA
Bottom land
MOUND
One Mile North of
NEWTOWN
From Description of Ancient Works
IN OHIO BY
CHARLES WHITTLESEY,
1850.

south of the turnpike forming the first terrace of the Ohio river and Five mile creek, shows numerous evidences of its having been formerly occupied by an attelier or village (No. 2, group G).

From the ancient cemetery just mentioned, the ridge rises very rapidly and precipitously, until it reaches an elevation fully seven hundred feet above the level of the creek. On the top of this hill, on the lands of J. C. Brill, is located a mound that has an elevation of five feet. It is very symmetrical, and commands a view of over eight miles in all directions. On the lands of Mr. Moses Markley, in survey 608, and located on a hill top, is a mound (No. 4, Group G) four feet high, and forty feet diameter at base. A careful search throughout the territory occupying the central and eastern portions of the township, failed to discover any additional earthworks. Some, however, may possibly have been overlooked.

The symbols employed in the accompanying chart, designating the character of the different monuments, are in accordance with the international code of MM. Mortellet and Chantre,* and Smithsonian Circular in reference to American Archæology.† The two supplemental plans, one of the earthworks on the Turner farm (No. 1, Group D), and the other of the great mound east of Newtown, are copied from Plate iii., Art. 7, Vol. iii., *Smithsonian Contributions* by Charles Whittlesey. The earthworks were erroneously located, by that gentleman, in Clermont county, but they are in Hamilton county, as elsewhere stated. The great mound is one mile east of, instead of north of, the village of Newtown, and is located near the road leading from Newtown to Batavia, instead of being on the road leading from Newtown to Milford, as stated by Col. Whittlesey. Many of the earthworks in this vicinity are being wantonly destroyed by curiosity-hunters who have no other object or desire seemingly than to destroy that which, to the archæologist and ethnologist, is of the greatest importance. In conclusion, I would again extend my thanks to Mr. Wm. Edwards, of Newtown, for his very valuable assistance in locating accurately many of the monuments, and for valuable information regarding them. Acknowledgments are also due to Messrs. William Archer and Charles F. Low, for their valuable assistance in preparing the accompanying chart ; and to Dr. F. W. Langdon for revision of the proof-sheets.

MADISONVILLE, HAMILTON CO., O., *October* 29, 1881.

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* Smithsonian Report, 1875.

† Smithsonian Miscel. Col., 316, 1878.

SUBCARBONIFEROUS FOSSILS FROM THE LAKE VALLEY MINING DISTRICT OF NEW MEXICO, WITH DESCRIPTIONS OF NEW SPECIES.

By S. A. Miller, Esq.

Prof. E. D. Cope, of Philadelphia, returned from his last annual exploring expedition, in the Western territories, with a collection of invertebrate fossils, from the Lake Valley Mining District of New Mexico, which he, very kindly, submitted to the writer for determination and definition. They are from rocks of Subcarboniferous age, and belong to the Burlington or Keokuk Group, but most likely to the former. The following remarks and enumeration of species will shed all the light, in our possession, upon the age of the rocks.

1. *Strophomena rhomboidalis.*—This species, as it is now understood, is found in the Trenton, Utica Slate and Hudson River Groups of the Lower Silurian; in the Clinton, Niagara and Lower Helderberg Groups of the Upper Silurian; in the Upper Helderberg, Hamilton and Chemung Groups of the Devonian; and in the Waverley, Burlington and Keokuk Groups of the Subcarboniferous, in America. It is not known to the author higher than the Keokuk. Its vertical range exceeds that of any other species that occurs in these formations, or in any other rocks of the known world, and its geographical distribution extends to every continent where the strata of these ages have been studied and described. Its form is subject to many variations, and these have received distinct names in different formations, as *S. tenuistriata* in the Lower Silurian, *S. depressa* in the Upper Silurian, and *S. rhomboidalis* in the Devonian. And, so far as the author has observed, it would appear that the Lower Silurian specimens are usually smaller and have fewer concentric wrinkles over the visceral region than those found in the higher strata of the Upper Silurian and Devonian formations, and that the length of the front and lateral margins, from the geniculation, in the Upper Silurian specimens, is usually greater than it is in Lower Silurian, Devonian or Subcarboniferous specimens ; but these differences are not so constant as to form inflexible characters, and hence it is that many of the learned and better palæontologists have classed them all together under the first and oldest specific name. On the other hand, the similarity between specimens collected in rocks of the same formation in distant countries is remarkable. This is most strikingly illustrated by the fact that a

number of specimens may be selected from the Upper Silurian rocks, in the island of Gottland, in the Baltic sea, and mixed with a like number of specimens from the upper part of the Niagara Group, at Waldron, Indiana, and it will be found extremely difficult for an experienced collector to separate them.

2. *Spirifera rockymontana.*—This species is represented by a single, small, somewhat distorted specimen, but there is very little doubt about the identification.

3. *Spirifera striata.*—This species is found in Bolivia, Ireland, England and Europe, as well as other distant localities, but is rare in the Mississippi valley and the Appalachian range. It is an everchanging species, and yet, throughout all its variations and wide geographical distribution, it is known only in the Subcarboniferous. It occurs in New Mexico in all its forms, from less than an inch to three inches in width, and having a length, in some specimens, equal to the width, and in others but little more than half as great. The hinge line occurs shorter than, equal to, and longer than the greatest width of the valves below. The plications are finer on some specimens than on others, and increase in number with the growth of the shell. Throughout all the changes, the ventral valve distinguishes the species by the almost uniform width of the cardinal area, and the gradually widening mesial sinus toward the front, with a corresponding increase in number of the plications.

4. *Athyris lamellosa.*—This species occurs in the Subcarboniferous of Europe, and has been found within the Mississippi valley, and at other places in the West.

5. *Athyris planosulcata.*—This species occurs in the Subcarboniferous of Europe, and in the Keokuk Group of Iowa and Illinois.

6. *Orthis resupinata.*—This species occurs associated with *Spirifera striata*, at various localities in Europe, but is quite rare in America.

7. *Orthis michelini.*—This is another species of world-wide distribution and great vertical range. It occurs in the Burlington, as well as in all the other groups of the Subcarboniferous.

8. *Productus semireticulatus.*—This species, again, is world-wide in its distribution, and is common to the Burlington and Keokuk Groups.

9. *Productus vittatus.*—This species was described from the Keokuk Group of Iowa.

10. *Rhynchonella pustulosa.*—This species was described from the Burlington Group of Iowa.

11. *Platyceras æquilaterale* (misspelled equilatera).—This species

occurs in the Keokuk of Indiana, Illinois, and Iowa, but is more rapidly expanding than the form from New Mexico. This difference can hardly be of specific importance.

12. *Proetus peroccidens.*—This species was described from the Subcarboniferous of the Rocky Mountain region, and though our specimen is quite fragmentary it probably belongs to it.

13. *Amplexus fragilis.*—This species was described from the Keokuk Group of Iowa, but it also occurs in the Burlington, in the same State, and it is common in the Keokuk of southern Kentucky.

14. *Cyathophyllum subcæspitosum.*—This species was described from the Carboniferous of the west, and compared with *Cyathophyllum pseudo-vermiculare* from the Subcarboniferous of Ireland, without longitudinal sections. The differences between the species are not readily determinable without cut sections, and it is, therefore, a matter of doubt to which species our specimens belong.

15. We have also two undetermined species of *Zaphrentis*, two undetermined species of Bryozoa belonging to the family *Fenestellidæ*, and the fragment of an *Orthoceras*.

It is, however, the appearance of the crinoids, rather than the above-mentioned species, that inclines us to refer the rocks to the age of the Burlington, instead of the Keokuk. Brachiopods and corals frequently have an extended vertical range, but crinoids are usually confined to a few feet, and it is an exceedingly rare occurrence for a species to pass from one group to another. The separation of the Burlington from the Keokuk could hardly be maintained were it not for the great change in the character of the crinoids. Of course, in Iowa and Missouri, a cherty layer, which Hall, in defining these groups, placed at the base of the Keokuk, separates them; but even here they are so intimately blended, that some authors refer the chert layers to the Upper Burlington. Without any information regarding the appearance of the rocks, in Lake Valley, or whether the fossils are all from the same elevation or not, and looking at the fossils above mentioned, and those hereafter to be mentioned and described, and supposing them to come from substantially the same elevation, we would confine the rocks between the base of the Burlington and top of the Keokuk, with the probabilities in favor of the age of the Upper Burlington.

There are in this collection three species of *Platycrinus*, one of them truncated at the base like *P. wortheni*, and another having the form of *P. planus*, though neither species is in condition to be described, and

one hereinafter defined. With these, there are eight specimens of *Actinocrinus*, belonging to six different species, two of which are hereinafter described, one cast of a *Dorycrinus*, and one *Dorycrinus* which is defined, and also numerous fragments of crinoid columns.

ACTINOCRINUS DALYANUS, n. sp.

Plate VII., fig. 1, view of the azygous side, natural size; fig. 1*a*, view of the posterior or side opposite the azygous side of another specimen, natural size.

Body below the arms, turbinate, truncate at the base, summit conical and produced into a proboscis. The general form is much like that of *A. cœlatus*, though the base is not so broadly truncated.

Basals.—Basal plates twice as wide as high, and thickened at the base.

First radials.—First radials about as wide as high, two heptagonal, and three hexagonal.

Second radials.—Second radials wider than high, three of which are pentagonal, and two hexagonal.

Third radials.—Third radials a little wider than high, hexagonal, and supporting upon each of the upper sloping sides a single secondary radial.

Secondary radials.—The secondary radials are short, pentagonal, and support upon each of the upper sloping sides a single brachial plate from which the free arms arise.

Regular interradials.—Regular interradials four, the first heptagonal or octagonal, about the size of the third radials, succeeded by two smaller plates, and these by a single plate resting between the secondary radials.

Azygous interradials.—The first azygous interradial is hexagonal, of about the same size as the first radials. It is succeeded by two plates, and these by three, above which only a single plate appears to occur.

Arms.—Arms twenty.

Surface.—The surface is ornamented with a tubercle in the central part of each plate, from which a ridge radiates toward the middle part of each of the sides, uniting at the sutures with like ridges from the adjoining plates, thus forming a stellate and tuberculous decoration.

The summit is covered with numerous papilliform, polygonal plates.

The specific name is in commemoration of Mr. George Daly, late manager of the Lake Valley silver mines, and a noted mining engineer of superior endowments. He was killed by the Apache Indians.

ACTINOCRINUS COPEI, n. sp.

Plate VII., fig. 2, view of the azygous side, natural size ; fig. 2*a*, view of the opposite or posterior side, natural size; fig. 2*b*, view of the vault or summit.

Body broadly turbinate below the arms, slightly truncate at the base, and depressed convex on the summit. Basal plates about three times as wide as high. First radials wider than high. Second radials wider than high. Third radials wider than high, and supporting upon each of the upper sloping sides a single secondary radial. The secondary radials are short and broad, and support upon the upper sloping sides a single brachial plate from which the free arms arise. Arms twenty.

The first regular interradial is about the size of the third radials, it is succeeded by two smaller plates, and these by one or two plates resting between the secondary radials. In the latter respect there is a difference in the interradial spaces. The first azygous interradial is of about the same size as the first radials. It is succeeded by two plates, and these by three, above which there appears to be only a single plate.

The plates in the calyx are about the same in number and position as in *A. dalyanus*, but they are wider in proportion to their height.

The summit is covered with numerous conical polygonal plates, with the exception of a large subcentral aperture. Broad shallow depressions appear near the margin, which become well defined channels between the arms, especially upon the azygous side. A cast would no doubt show more strongly these depressed interbrachial spaces.

The surface of the calyx is very highly ornamented by stellate ridges and sculptured depressions, with verrucose and granulous elevations. It is not surpassed in ornamentation by any species belonging to the genus.

The specific name is in honor of the distinguished naturalist, to whose collection it belongs.

DORYCRINUS LINEATUS, n. sp.

Plate VII., fig. 3, view of the azygous side ; fig. 3*a*, view of the posterior or side opposite the azygous side, natural size.

Body of medium size, turbinate below the arms, truncate at the base, summit depressed, conical, with a prominent subcentral spine.

Basal plates twice as wide as high, and extending below the facet for the attachment of the column. First radial plates a little wider than high, three hexagonal, and two heptagonal. Second radials less than half the size of the first, twice as wide as high, and quadrangular

in outline. Third radials a little wider at the upper lateral angles than the second radials, pentagonal in outline, and supporting upon the upper sloping sides a single pair of smaller secondary radials, each of which supports two brachial plates from which the free arms arise, except as to the right anterior series (the left anterior series is destroyed at this place in our specimen), where three secondary plates appear to rest upon the third radial, and support two brachial plates each, from which free arms arise.

A single regular interradial plate fills the space to the top of the secondary radials. It rests between the upper sloping sides of the first radials, and is bounded on either side by the second and third radials, and a secondary radial, and on the top by an interbrachial plate, thus giving it nine sides. Its size is about that of a first radial.

The first azygous interradial is longer than wide, octagonal, and a little larger than the first radials. It supports three interradial plates, the central one of which is followed by an interbrachial plate, which connects with others extending to the opening in the vault.

The summit is covered with polygonal, crateriform plates, and a strong subcentral spine approaching the azygous side. The opening is situated below the base of the spine above the level of the arm openings, and is surrounded by slightly projecting plates.

Supposing the left anterior side to be like the right anterior, in accordance with the usual structure, the species will have twelve arm openings, and if there are two arms to each opening, as is usual in the genus, there will be twenty-four arms.

The plates of the body are all more or less tumid. The first radials have an arcuate elevation, and the second radials a tranverse enlargement. The whole surface is marked with fine lines, very conspicuous under a magnifier, from which the specific name is derived. Those on the body below the arms are longitudinal, but those on the vault seem to radiate from the crateriform depressions in the plates.

PLATYCRINUS POCULUM, n. sp.

Plate VII., fig. 4, basal and posterior view, natural size.

Body of medium size, sub-hemispherical or deep saucer-shaped. The three basal plates form a shallow pentagon less than one fourth the height of the cup. The facet for the attachment of the column is subcircular or slightly elliptical and full one-third the diameter of the base. The first radial plates are twice as large as the basals, subquadrangular, a little wider than high, and gradually increase in width from below up-

ward. The facet for the reception of the second radial forms a semicircular depression in the middle of the upper part, and occupies about one half of the summit and extends down more than one third the length of the plates. Sutures, except between the basals, are impressed or distinctly channeled, and the surface is covered with well-defined nodes. Two rows on the pentagonal base surround the columnar facet, and two rows occur on the first radials below the semicircular facet for the second radial.

This species is founded upon a single specimen, showing only the parts above described. It has some weight, in connection with the other species of crinoids, as evidence, in determining the age of the rocks, and can, no doubt, be readily identified, imperfect as the type specimen may be.

Trematopora americana, n. sp.

Plate VII., fig. 5, fragment natural size; fig. 5*a*, magnified view.

This species consists of irregularly cylindrical, ramose, hollow stems or branches. The interior is evidently lined with an epitheca. The diameter of the stems examined is from two tenths to six tenths of an inch, and the thickness of the corallum is from less than half a line to a line. The thickening of the corallum is not dependent upon the size of the branches, but seems to be the result of irregular growth. The cell tubes are subcircular and irregularly distributed. The apertures are margined by a projecting lip which sometimes overshadows the lower part of the opening. There are usually about four cell tubes in one tenth of an inch where the intervening spaces are about one and a half times the diameter of the tubes, but owing to the scattered distribution of the tubes, the proportion is variable. There is neither uniformity in the shape of the branches, nor in the order of arrangement of the cells.

Trematodiscus rockymontanus, n. sp.

Plate VII., fig. 6, view, natural size.

Shell medium size, discoidal; umbilicus wide, showing the inner whorls and perforated in the middle; volutions very gradually increasing in size, narrower transversely than from the dorsal to the ventral side, and slightly embracing; septa slightly arching forward on the periphery, and surface ornamented by fine revolving lines. Siphuncle and body chamber unknown. It is supposed that about one whorl has been broken from the specimen described and illustrated.

CAMAROPHORIA OCCIDENTALIS, n. sp.

Plate VII., fig. 7, dorsal view; *7a*, ventral side; *7b*, front view.

Shell of variable size, some in the collection having less than one fourth the dimensions of the specimen illustrated. General form subtrigonal, wider than long, truncated in front, straight upon the postero-lateral slopes and rounded to the front. Dorsal valve gibbous, most convex anteriorly. The posterior lateral slopes are abrupt, the anterior lateral slopes and the front are more or less sharply geniculated, and extend down, meeting the ventral valve near the middle of the front face, but forming almost the entire anterior lateral sides before joining the opposite valve. Mesial elevation flattened anteriorly, but well defined to the middle where it is no longer traceable; a sinus arises anteriorly in the middle of the mesial elevation, and becoming well defined extends to the beak which is incurved beneath the beak of the ventral valve. There are from seven to nine angular plications on the mesial elevation, and about the same on either side, making from 21 to 27 plications, on the specimens examined. Ventral valve somewhat flattened, most convex in the central part, from which it slopes in all directions, but flattens out or curves up a little, at the antero-lateral sides, where it is very sharply geniculated, and unites with the opposite valve; toward the front the curvature increases, terminating in an abrupt geniculation and extension to meet the other valve in the middle of the truncated front. The beak is pointed and curved over upon that of the dorsal valve. The mesial sinus is broad and defined only on the anterior half of the valve. The plications are the same in number as those that occur on the dorsal valve.

The surface of both valves is ornamented by fine concentric lamellæ of growth, which, in crossing the angular plications, make a series of zigzag lines, that also ornament the truncated front to the point of union of the serrated valves. This is a handsome species readily distinguished from all hitherto described.

ORTHIS DALYANA, n. sp.

Plate VII., fig. 8, ventral view; fig. *8a*, dorsal view; fig. *8b*, profile view.

Shell depressed, suboval in outline, and length about equal to the greatest width, which is at the anterior third. Dorsal valve most convex above the middle, from which it inclines in all directions to the margin, forming a broad, flattened inclination toward the front. Beak

small, pointed and extending beyond the cardinal area. Ventral valve most convex near the beak, sloping off wedge-shaped toward the front, and very rapidly, at first, toward the posterio-lateral sides, but flattening out before reaching the margins. The beak is elevated, sharp, slightly incurved, and extends beyond the beak of the opposite valve. The length of the linear area is about half the width of the shell.

The surface is ornamented by numerous fine, round, radiating striæ, which increase by implantation, and are crossed by several strong, concentric, imbricating lines of growth, and intermediate finer concentric lines. This species, in its surface markings, resembles *O. vanuxemi* from the Devonian, but the striæ are finer and more numerous, and it may readily be distinguished from other species found in rocks of its own age.

Spirifera temeraria, n. sp.

Plate VII., fig. 9, ventral view ; fig. 9*a*, dorsal view : fig. 9*b*, front view.

Shell small, transversely subelliptical, moderately gibbous, hinge line less than the width of the shell, and cardinal extremities rounded. Dorsal valve convex from back to front ; mesial fold convex, much elevated at the front, while at the anterior sides of the mesial fold, the shell is rapidly curved down, and produced to meet the truncated extension of the opposite valve on each side of the sinus ; the beak is of moderate size, and arched over the linear area. Ventral valve, gibbous in the umbonal region, and sloping to the front and sides ; the sinus, commencing with a shallow, rounded depression in the umbonal region, becomes more and more strongly defined, and terminates in a deep, somewhat angular, and much produced extension in front. The beak extends beyond the beak of the opposite valve, and is incurved over the area, which is almost linear.

The surface is ornamented with very fine radiating lines, which are crossed by numerous fine concentric lines, and a few stronger imbricating lines of growth. There is only a single specimen of this species in the collection, and it is therefore supposed to be a rare form—hence the specific name.

Spirifera novamexicana, n. sp.

Plate VII., fig. 10, ventral view ; fig. 10*a*, dorsal and cardinal view ; fig, 10*b*, front view.

Shell more or less gibbous, transverse, triangular, and having the cardinal angles extended into mucronate points. The dorsal valve is

convex from the cardinal line to the front with the greatest convexity in the middle. The mesial fold is round and truncated by the extension of the sinus in the opposite valve. The beak is scarcely defined, and does not project beyond the narrow area which extends the whole width of the shell. Ventral valve more gibbous than the dorsal valve, and most convex at the posterior third. The mesial sinus is rounded, and gradually widens from the beak to the front where it is produced so as to truncate the mesial elevation of the opposite valve. The umbo is prominent, and the beak sharp and incurved over the fissure. The area extends to the cardinal angles, is slightly concave, especially in the middle part, and is transversely striated.

The surface on either side of the mesial fold and sinus is marked by about six simple rounded plications, which become less prominent as they recede from the fold and sinus. The entire surface is covered by fine, concentric, imbricating lamellose lines, which become more marked toward the front of the shell.

RHYNCHONELLA TUTA, n. sp.

Plate VII., fig. 11, ventral view; fig. 11*a*, dorsal view; fig. 11*b*, front view; all natural size.

Shell small, suboval, greatest width at the anterior third, length and width sub-equal, ventral side most convex.

Ventral valve, gibbous, highly convex in the central region; mesial sinus, not clearly defined; beak acute and closely incurved upon the beak of the opposite valve.

Dorsal valve, moderately convex; mesial depression, imperfectly defined; beak acute and incurved beneath the beak of the opposite valve.

Surface marked by about eighteen fine, sharply angular, simple plications on each valve.

This species is founded upon four specimens, each of which is more or less injured. The lateral and front margins appear to be in one plane. There is no species in rocks of the same age with which it is necessary to make any comparison.

DESCRIPTION OF NEW SPECIES OF FOSSILS FROM THE HUDSON RIVER GROUP, AND REMARKS UPON OTHERS.

By S. A. Miller, Esq.

Dendrocrinus erraticus, n. sp.

Plate VIII., fig. 1, view of the azygous side, natural size; fig. 1*a*, posterior or opposite view.

Body obconoidal, rounded at the base, a little longer than the greatest diameter at the top of the first radials, plates smooth, sutures well marked, and more or less channeled above the basals, with depressions at the angles.

Basals forming a little cup about half as high as wide, plates pentagonal, the upper sloping sides shorter than the lateral sides. Subradials regularly hexagonal, much larger than the basals, and nearly as wide as long. Three of the first radials pentagonal, length and width subequal, size about equal to the subradials; one on the left side hexagonal, and larger than the other first radials; the first and second plates in the left anterior series, a little smaller than the first radials, the lower one pentagonal, and the upper hexagonal. The superior side of these plates is equal to the greatest width. The succeeding plates in the first radial series are as wide as the first radials, and have a length about equal to one third the width. A division takes place on the third plate above the first radial in each of the anterior rays, and on the fourth plate in the left lateral ray. Only three or four plates, in each of the arms, are preserved above this division, in our specimen.

The first azygous plate is hexagonal, and a little larger than the subradials. The second is hexagonal, and smaller than the subradials. It supports upon its upper side two series of plates, the one on the right composed of very small plates, and the succeeding plate in the left series bears upon its left side a series of minute plates that intervene between it and the left anterior ray, so that, at this part of the azygous side, we have a width of three plates, but the marginal rows are very small. In our specimen we have preserved, in the azygous interradial area, seventeen plates, six of the larger ones form the central series, four minute plates intervene between this series and the right anterior free arm, and seven between it and the left anterior free arm.

The column, as indicated by the columnar facet, is very small.

This species bears some resemblance to *D. latibrachiatus*, from the Hudson River Group, in the Island of Anticosta, and yet it is so distinct as not to require any comparison.

The specimen described, was found near Cincinnati, where it had evidently been drifted, and is supposed to be from the upper part of the Hudson River Group, possibly from Hamilton or Warren county. It now belongs to the author's collection.

Internal Structure of Lichenocrinus.

Plate VIII., fig. 2, erect, internal lamellæ of Lichenocrinus, natural size ; fig. 2*a*, magnified view.

In 1874, the writer described the internal structure of *Lichenocrinus tuberculatus*, as follows : "Interior filled with upright lamelliform plates, radiating from a central point, on which the exterior plates appear to repose" (*Cin. Quar. Jour. Sci.*, vol. i., p. 346). No single specimen suitable for illustrating this fact was then known. Recently, I received from Dr. D. T. D. Dyche, of Lebanon, O., a specimen preserving the upright lamellæ, and having all the exterior plates removed. The lamellæ bifurcate so that the intervening spaces do not exceed the thickness of the lamellæ at the circumference. The bifurcations do not take place opposite each other in adjoining lamellæ, but at different distances from the center, so that uniformity is preserved in the width of the inter lamellar spaces. The divisions take place within the central depression for the columnar attachment, on the convex circular elevation, and near the circumference.

Dr. Dyche's specimen is from the upper part of the Hudson River Group, within the range of *L. tuberculatus*, and therefore, probably, belongs to that species, though it might, of course, belong to a distinct species as this structure is characteristic of the genus.

Cuneamya elliptica, n. sp.

Plate VIII., fig. 3, view of the left side of a cast, natural size ; fig. 3*a*, view of the right side of a smaller cast.

Shell very inequilateral, subelliptical, about one half longer than high, greatest height posterior to the beaks, ventricose, and broadly inflated in the umbonal region; anterior end projecting and rounding from the lunule to the base, which forms nearly a semi-elliptical curve; hinge line, slightly arching; posterior end somewhat truncated in the upper part, and narrowly rounded in the posterior basal region; beaks, prominent, incurved; posterior umbonal region very prominent, and rounded to the posterior third of the shell, and then sloping to the posterior basal region; anterior umbonal region forming a convex elevation extending from the beak to the base, and directed a little backward. A shallow depression, commencing near the beak and

descending to the base, gradually widening and deepening, separates the anterior from the posterior umbonal region. Surface marked with numerous imbricating lines or concentric costæ.

The measurement of three casts is as follows:

1. Length, 1·95 inches; height, 1·20 inches; thickness, 9-10ths inch.
2. Length, 1·70 inches; height, 1·05 inches; thickness, 75-100ths inch.
3. Length, 1·30 inches; height, 80-100ths inch; thickness 65-100ths inch.

This species is distinguished from *C. miamiensis* by its elliptical shape, projecting anterior end, more ventricose posterior umbonal region, less ventricose anterior umbonal region, curving cardinal line, less prominent beaks and other characters, so that the two species may be recognized at a glance. It is distinguished from *C. neglecta* by its more elliptical shape, better defined sulcus, more ventricose and less angular posterior umbonal slope, and other characters that enable us to distinguish the species even from the most imperfect casts.

Hall and Whitfield described *C. miamiensis* as a small shell, but I have a specimen of it much larger than the largest illustrated specimen of *C. elliptica*, and others as small as those which they described.

This species is from my own collection, and was found in the Hudson River Group, near the top of the hills, at Cincinnati.

PYANOMYA, n. gen.

[Ety.—*Pyanos*, a bean ; *Mya*, a genus of shells.]

Small, inequilateral, bivalve shells, with thin, fragile, ventricose, edentulous valves. Valves united by an external ligament. No escutcheon. Type, *Pyanomya gibbosa.*

This genus is proposed for edentulous shells found in the Hudson River Group without well-marked muscular impressions, or scars preserved on the casts, and which have heretofore been undescribed.

PYANOMYA GIBBOSA, n. sp.

Plate VIII., fig, 4, view of the left side, natural size ; fig. 4*a*, view of the right side ; fig. 4*b*, cardinal view.

Shell small, very inequilateral, subovoid in outline, with the larger end posterior; valves very ventricose or gibbous in the middle or posterior umbonal region; edentulus; beaks very small, and scarcely projecting beyond the cardinal line; ligament, external; hinge line, arcuate posteriorly, and strongly bent down in front of the beaks; no escutcheon; lunule, not distinguished; anterior end projecting and sharply rounded into the semi-elliptical base; posterior end more broadly rounded; umbonal region, swelling posteriorly, and rounding off in the

posterior basal region. Surface smooth or marked by very fine concentric lines; muscular impressions not known.

Casts of this species occur in the Hudson River Group, on the hills, at Cincinnati, but the shell is extremely rare. The greater part of the shell is preserved in the specimen illustrated. It was found by W. J. Patterson, Esq., of Cincinnati, to whose collection it belongs, and, so far as I know, with the exception of a specimen preserving part of the shell in my own collection, no other specimen preserving any part of the shell has ever been found. The casts are very scarce and usually very imperfect, so much so that after the examination of forty or fifty specimens I have been unable to detect any muscular impressions or scars whatever.

Orthoceras cincinnatense (S. A. Miller).

(Orthoceras cincinnatense, S. A. Miller, 1875, *Cin. Quar. Jour. Sci.*, vol. ii., p. 127).

Plate VIII., fig. 5, this specimen was used originally as a type; fig. 5*a*, this is worn so as to make the chambers appear to be arched backward.

This species is distinguished from *O. byrnesi* by the more distant septa, and more rapidly tapering shell.

Orthoceras harperi (S. A. Miller).

(Orthoceras harperi, S. A. Miller, 1875, *Cin. Quar. Jour. Sci.*, vol. ii., p. 128.)

Plate VIII., figs. 6 and 6*a*, both of these specimens are in the author's collection, and were used as type specimens.

This species is distinguished by the closeness of the septa, and the abrupt enlargement of the siphuncle in each chamber.

Orthoceras fosteri (S. A. Miller). Plate VIII., figs. 7 and 7*a*.

(Orthoceras fosteri, April, 1875, *Cin. Quar. Jour. Sci.*, vol. ii., p. 127.)

(Syn.—*Orthoceras duseri.* Hall and Whitfield, *Ohio Pal.*, vol. ii., p. 97, pl. iii., figs. 2-4.)

Orthoceras duseri was published several months after the publication of *Orthoceras fosteri*, and seems to be clearly a synonym, as it came from the same locality, and possesses nearly the same measurements.

Orthoceras byrnesi (S. A. Miller). Plate VIII., fig. 8.

(Orthoceras byrnesi, S. A. Miller, 1875, *Cin. Quar. Jour. Sci.*, vol. ii., p. 126.)

This is the most abundant species found at the stone quarries on the hills in Cincinnati.

ON THE VARIABILITY OF THE ACORNS OF QUERCUS MACROCARPA, Michx.

By Jos. F. James,

Custodian, Cincinnati Society of Natural History.

It is a well known fact that all forms of life are subject to variation, but to what extent the variation is carried is a subject of much discussion. The almost universally acknowledged belief now is, that all the species of any one genus are the descendants of a common ancestor, and more remotely, the different genera of an order are likewise the modified descendants of a single form. Yet, nothwithstanding this general belief, many are unwilling to admit that we see in the life about us, any tendency toward the formation of a new species.

Now it is much to be doubted if such a thing as a species has any existence in nature. The term is one which scientists have agreed to apply to an assemblage of individuals, which have certain characteristics in common ; but certain of these characteristics may be wanting in some individuals; and in a large number of individuals of one acknowledged species, we may and do find certain features changing, so that one species merges into another so imperceptibly that the line to be drawn between them is indistinguishable. This has come to be recognized to such an extent that many naturalists now hold that the true method of classification is to group around certain centres, forms which have some thing in common. To say that this or that form belongs to a certain group of which some other form is the type.

It is not the purpose here, however, to enter on a discussion of the meaning of the term species, nor of the limits of species, but to call attention to certain variations which have been noticed in a single species of plant, viz.: the *Quercus macrocarpa*, Michx., the Bur or Mossy Cup Oak. This tree, one of the finest of our Oaks, is remarkable for the peculiar moss-like fringe which borders the cup of the acorn, and which is present in no other species of *Quercus* of North America. The leaves of the tree are very variable, both in size and in outline. They are lobed, cut, pinnatifid and parted in such various degrees that it is hardly possible to find two of them alike ; and leaves from the same tree would, if found in a fossil state, be ascribed to entirely different species.

It is, however, to the acorns which I wish to call attention. According to Michaux, these "are oval, and inclosed for two thirds of their

length in a thick rugged cup, which is generally bordered along its upper edge with fine, long flexible filaments. Sometimes, however," he adds, "in compact forests, or in very temperate regions, the filaments do not appear, and the edge of the cup is smooth and bent inward."* Gray says,† that the cup is "deep, thick and woody, conspicuously imbricated with hard and thick-pointed scales, the upper ones awned, so as usually to make a mossy fringed border; acorn broadly ovoid, half immersed in or entirely inclosed by the cup. . . . Cup very variable, especially in size, from 9″ to 2′ across."

The series of sketches I have prepared illustrate this variability of the acorn in a remarkable manner. Figure 1 is the type form with the acorn two thirds immersed in the cup, and the latter furnished with a delicate fringe on the upper edge. Figure 2 is from a specimen from Hardin county,‡ Ohio, in which the acorn is almost wholly concealed in the cup, and the fringe almost hides it from view. Figure 3 is a top view of a widely different form. In this the cup is nearly an inch and a quarter across, and the fringe projects at least half an inch all round, making it two and a quarter inches in diameter. The acorn projects very slightly above the rim of the cup. Figure 4 goes again to the other extreme, for here we have a very small acorn, the cup slightly fringed, and leaving only a small portion of the apex of the nut exposed. In figure 5, we have a cup one and a half inches in diameter, in which the fringe has grown down inside the cup, lining it all around, and forming a soft bed for the nut to rest on.§ In figure 6, we have an acorn in which the cup conceals three fourths of the nut, and is almost destitute of any fringe. In figure 7, we have an entirely different form again, for here the cup conceals about one half the acorn, the walls are very thin, and it is entirely destitute of any fringe whatever. Figure 8 represents the variety *Olivæformis*, Gray, from Hardin county, O. Here we see an oblong acorn, with a cup half concealing it, and with a very slight fringe.

Thus we have here eight different looking acorns, all known to belong to the same species, and more than one to be found, perhaps, on the same tree. There are all gradations from no fringe at all on the

* North Am. Sylva, vol. i, p 34. The figure given by Michaux shows the character admirably.

† Manual, p. 451.

‡ This and the following figures are taken from specimens given me by Dr. John A. Warder. Specimens from which figs. 2 and 8 were made, were collected by Mr. Hampton of Hardin county.

§ The nut is not shown in the figure, only the cup showing the fringe lining the interior of it.

cup, to one which has a fringe half an inch long. The cups are shallow and deep, thick and thin, extending half way up the acorn, reaching to its apex, or almost entirely concealing it.*

It seems to me that in this marked tendency to variability in the *Quercus macrocarpa*, we have the beginnings of what might, in the course of time, come to be considered several distinct species. If the tree springing from the acorn distinguished by the thin-walled cup, destitute of fringe, should produce a preponderance of acorns of the same character, and if this character should be transmitted from generation to generation, as we have every reason to suppose may be the case, then in the course of time a new variety or species will have arisen. If, further, the acorn with the long fringe produces in its turn a tree bearing acorns like the original one, and its characters be also transmitted and finally fixed, another and a widely different variety or species from the thin-walled variety will have arisen. If now we imagine through any cause all the intermediate forms to become extinct, and only the extremes remain, it would be hard to realize that two such different looking forms could have arisen from one which produced both kinds of acorns.

Such facts as have been given in this article, and cases of the same kind, are by no means rare, should make naturalists careful how they make new species. It is much more creditable in the present state of our knowledge to reduce the number of species, than to increase it. For it is very much easier to arbitrarily establish the bounds of a species, and to say this is one, and that another, than to say this species and that species are forms which in the past were closely connected; and to say that they ought now to rank as varieties, either one of the other, or else of some other species possessing characters common to both.

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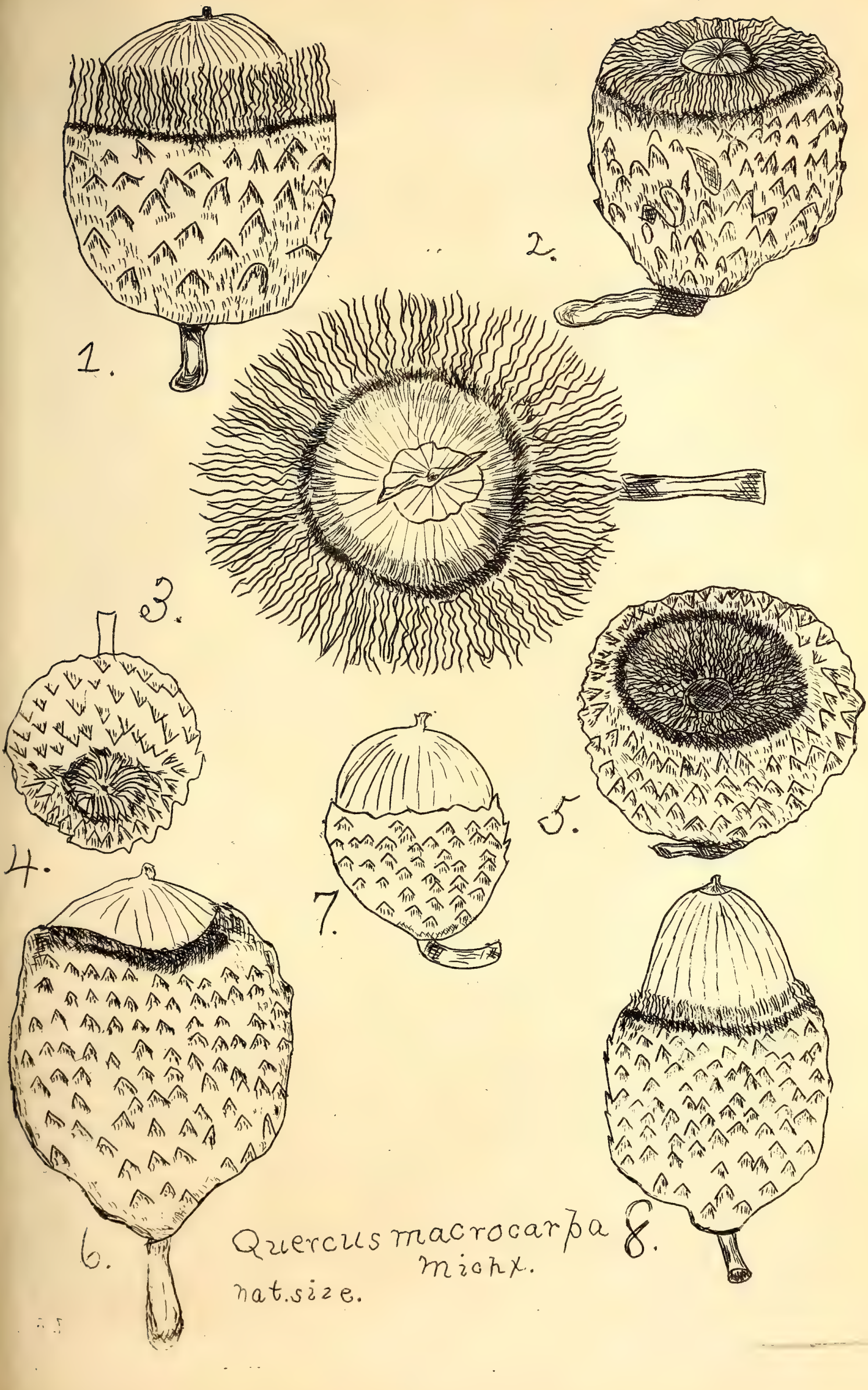
* The oak said to most closely resemble our *Q. macrocarpa*, which, by the way, is principally confined to the Mississippi valley, is the *Q. cerris* of Europe. This is as variable as the *Q. macrocarpa*. It is a native of middle and south Europe, and of western Asia, and Loudon in his Arboretum et Fruticetum Britannicum, remarks on the tendency to sport which is characteristic of it. He gives no less than fourteen varieties of it, and these vary from forms with pinnatifid or sinuate leaves, to dentate, to subevergreen, and even evergreen leaves. He says nothing about any variation in the fruit.



Quercus macrocarpa Michx.
nat. size.

SOME NOTES ON AMERICAN LAND SHELLS.

No. II.

By A. G. Wetherby,

Prof. Geology and Zoology, University of Cincinnati.

During the past summer I spent about twelve weeks among the mountains of North Carolina and East Tennessee, and in regions of special interest to the student of N. A. conchology, because of the number of new species of land shells so recently described from there by Mr. W. G. Binney, and to which list two more must now be added, the *Patula bryanti*, Prof. Harper, and the *Helicodiscus fimbriatus*.

Roan Mountain rises to a height of 6,391 feet above sea level. It is composed entirely of metamorphic and plutonic rocks, the former dipping at a high angle to the southeast, and the latter being thrust through them in various directions. The structure of the mountain is essentially monoclinal, and its present relief is the result of erosion. The slopes are heavily timbered to the very margin of the "bald," though the trees are stunted and dwarfed at the top, with the exception of the firs and balsams, which seem to have their normal habitat. Notwithstanding the large number of species which has been collected here, the number of individuals, except in a few cases, is comparatively small, and as the search for shells was prosecuted with very great vigor, by several members of my party, as well as by myself, I am able to speak authoritatively on this point. I wish, therefore, to put upon record the confirmation of a statement which I have previously recorded in this Journal, that regions of greatest diversity of types are not always regions populous with individuals. The forest on the slopes of this mountain are everywhere moist; the soil is exceedingly fertile, and the climate mild and equable. These are conditions favorable to this kind of molluscan life, but there is an almost absolute dearth of limestone, and here may be found one of the causes for individual scarcity.

I have submitted my collections to Mr. Thomas Bland, of New York, the highest authority on American land shells, and the notes which follow will be made upon the names as given by him. I may remark that all these species were collected by me, personally, and that the station was in every case carefully observed. None of the shells ex-

tended higher than the margin of the bald, and none of the larger species, of the genus *Mesodon*, were found by me at an elevation of more than 4,500 feet.

I can not say what has been the experience of others in this regard.

1. *Mesodon major*, Binney.—This shell, which has always been held by Mr. Bland to be a variety of *M. albolabris*, Say, is undoubtedly distinct. I obtained quite a large number of individuals, many of which were much larger than Mr. Binney's type, from an old windfall, where they were found crawling over the rotting logs very early in the morning and late in the afternoon, in wet weather. The animal is quite distinct from the *albolabris*, and the shells decidedly so. Among the shells were several albinos, and a variety of forms resulting from the comparatively greater or less elevation of the spire. The remarks of Mr. Binney on the shells and animal of this species, *Terrestrial Mollusks*, vol. v., pp. 316, 317, are verified by my observations. Found with these shells, and in precisely the same station, was a dentate variety of *M. albolabris*, Say. I regard this fact of the association of two distinct, but closely allied forms, in the same habitat and station, as a very suggestive one, which probably points either to specific differences or to the theory of geological remnants.

2. *Mesodon albolabris*, Say.—This species was found with the last, and was in every way, except in the presence of the parietal tooth, the normal type of the species. The shells are not as large as the ordinary form, and the lip is a trifle more widely reflected. The animal is much more active, and far less timid than that of *M. major*, as I had every opportunity to observe. I think that any collector who has the opportunity to observe these two shells in their native haunts, will not hesitate to regard them as being decidedly distinct, differing so widely as they do in size, coloration (of animal), habits, etc.

3. *Mesodon exoleta*, Binney.—This shell was found, somewhat sparingly, exhibiting no peculiar features.

4. *Mesodon thyroides*, Say. Very rare in this locality. A few dead shells only found.

5. *Mesodon diodonta*, Say.—This shell was found in considerable numbers, represented by a small, pale, thin variety, resembling specimens which I have had from Vermont, Maine and New York. It was in striking contrast with the large, heavy variety, found in Kentucky and Tennessee, and still more with the *M. chilhoweensis*, Lewis, found in the mountains of the western part of the metamorphic belt, and which has been called a variety of *M. diodonta*, Say. This species was

found at elevations varying from 3,000 to 3,500 feet, in the leaves about the loose rocks of tali, under cliffs, and occasionally under logs. The station of the large varieties mentioned above, is always near or at the base of limestone cliffs. *M. chilhoweensis* inhabits the open forest.

6. *Mesodon andrewsi*, W. G. Binney.—Besides the typical form of this shell, recently described by Mr. Binney, there occurs on the south-east slope of Roan, a large variety, having nearly twice the cubic capacity of Mr. Binney's type. The shell agrees well with his description of *M andrewsi* in nearly every other particular. The type of *M. andrewsi* was a thin shell, while these are quite solid in texture, of lighter color, and of more ponderous make up generally. But one animal was secured. This much resembled that of *H. thyroides*, except that the oculiferous tentacles were much shorter and stouter. The animal is very timid and sluggish. The species is comparatively rare, though a fair number of specimens was found. It is evidently a distinct, and well marked form.

7. *Mesodon wetherbyi*, Bland.—Shells which have been referred to this species occur somewhat sparingly at this locality. Like the specimens from the original station, the shells are covered with a thick coating of dirt, imbedded in the hirsute covering of the epidermis, which being carefully washed away leaves the shell of a pale greenish white color. These shells have a lamellar projection on the inferior surface of the peristome much like that of some varieties of *T. appressa*, and which is a character very distinct from that of the same region in the type. A very careful examination of the genitalia shows them to be much more like those of *Triodopsis*. Indeed, looking over the whole field, it seems not improbable that here we have another case of the union of characters of *Mesodon* with other groups, like that of *Stenotrema*, mentioned in my notes, No. 1. Mr. Binney says, *Terr. Moll.*, vol. v., p. 301, " *Triodopsis* does not differ from *Mesodon* or *Polygyra* in the character of its jaws." Again, p. 306, he says that the genitalia of *T. appressa*, resemble, in certain features, those of *Mesodon sayii*=*M. diodonta*. This shell certainly presents as many features that would ally it to *Triodopsis* through *appressa*, as to *Mesodon* through *dentifera*. In fact, I am inclined to the belief that the shell is not *Mesodon wetherbyi* at all, but a distinct species, probably a *Triodopsis*, and having the closest anology to *M. dentifera*, Binney, which certainly has some very strong claims to relationship to *Triodopsis* through *T. appressa*. The station of this species is always *in the dirt* under and beside rotting logs. It is very sluggish and timid, and very rare.

8. *Mesodon wheatleyi*, Bland.—Typical examples of this rare species were found on the southeastern slope of Roan, associated with *M. andrewsi*, var. *major*, and with a few other species. It presents no features of special interest, save its comparative rarity.

9. *Mesodon profunda*, Say.—I found two specimens of this species, the smallest I have ever seen. They are thin, light, semi-transparent, and ornamented with numerous fine, dark reddish brown lines. Other members of the party found occasional specimens, but the species is evidently rare in this locality.

10. *Macrocy disconcava*, Say.—This species is tolerably abundant here, and is undistinguishable from forms of *M. vancouverensis*, Lea, from California. The variety is slightly different from the typical form further north. I have a variety of this species taken at Pine Mountain, Kentucky, which is nearly equal in size to the largest specimens of *M. vancouverensis.*

11. *Zonites capnodes*, W. G. Binney.—Typical specimens occurred on the west slope of Roan, and the east slope of Iron Mountain.

12. *Zonites fuliginosus*, Griffith.—Several specimens occurred which I have referred to this species. Mr. Bland says, in one of his notes, "shape of aperture different," and in another place suggests a careful dissection of the animal. *Externally* the characters are so like those of the typical shells that I do not detect any difference.

13. *Z. lævigatus*, Pfr.—This shell is here represented by a globose variety, either the same or similar to that published by Mr. Binney, *Terr. Moll.*, vol. v., p. 103, fig. 23. This variety is much thinner and lighter in texture than the typical form. A species which I years ago separated as distinct, under the name of *Z. perfragilis*, was referred, as I think no doubt erroneously, to this form. The shell is quite distinct from that of *lævigatus.*

The varieties of this shell, ranging from Ohio to Texas, and occurring in the mountains as well as the lowlands, would form an interesting group for study.

14. *Z. demissus*, Binney.—Typical specimens.

15. *Z. ligerus*, Say.—This species is represented at this locality by a very large, very much elevated variety, having a remote likeness to the *Z. acerrus*, Lewis, but which is certainly the *Z. ligerus.*

From the typical *acerrus* it differs in the greater elevation of the spire, less polished surface, more distinct lines of growth, and as a result in the general facies. The shells can hardly be mistaken for each other by one acquainted with the species. The four forms, *ligerus*,

acerrus, *demissus*, and the Roan Mountain variety, are certainly very closely connected by varietal characters.

16. *Z. subplanus*, Binney.—This exceedingly rare species was found in very small numbers on a spur of Iron Mountain, as well as at a single locality on Roan. The station was under laurel leaves, in laurel thickets, and on a vein of decomposed quartzite.

The shells are larger than Mr. Binney's type, and very closely resemble the *Z. inornatus*, Say, except in being depressed above and below, and in having about one whorl more.

A careful dissection of the animal has shown me no characters separating it from *inornatus*. How far the fact of an extra whorl can be relied upon as a specific character may be inferred from the fact that many species in the mountains exhibit enormities in this regard. This shell is extremely rare, and from the difficulties surrounding its capture is likely to remain so.

17. *Z. inornatus*, Say.—A few specimens of the typical form of this shell occurred on the western slope of Roan. It did not occur with *subplanus*, whose only company was the *V. latissima*, Lewis.

18. *Z. sculptilis*, Bland. A few specimens of this rare species were found in the moss growing on the boulders lying in the valleys radiating from the western side of Roan. At other localities I have found it under logs, occupying nearly the same stations as its close ally, *Z. indentatus*, Say. The latter I did not find.

19. *Z. elliotti*, Redfield.—This species was found in considerable numbers, deeply buried in the rotten part of old logs, or on the under surface where they were deeply buried. The animal is carnivorous, devouring the *Patula perspectiva*, Say, found in the same stations. I have collected this shell at several localities in Kentucky and Tennessee, as well as in both the northern and southern extremities of North Carolina.

20. *Z. cerinoideus*, Anthony.—A few specimens only, associated with *Z. sculptilis* and *Z. andrewsi*, W. G. B.

21. *Z. placentulus*, Shuttleworth.—This shell has been generally referred to *Z. capsellus*, Gould. Mr. Bland makes the above determination, and says, " I do not think, at least I do not remember, that I ever saw the true *capsella*, Gld., but must have done so in Binney's coll." It is of interest to note this fact distinctly, that collectors in this region may be on the look out for the " true *capsella*." The shell in question is very rare, and occurs in moss and about moist boulders, like *sculptilis* and *cerinoideus*.

22. *Z. fulvus*, Drap. This species occurs here in limited numbers, at many localities. It presents no features of interest.

23. *Z. gularis*, Say.—The typical form of this species occurs in abundance under leaves and about stones and logs everywhere at this locality. Many of the specimens are much elevated, and of comparatively large size. An umbilicate variety occurs which is always more glabrous and more flattened. The variety which Dr. Lewis described as—

24. *Z. cuspidatus*, also occurs abundantly. Of this form, Mr. Bland writes, "I do not feel entirely satisfied that *cuspidatus* is distinct." It seems to me that the same treatment of the forms here included under one species, as has been given to the group embracing *fuliginosus*, *capnodes*, and *friabilis*, would give us two or three species instead of one.

But this is a question for the species makers to decide.

25. *Z. significans*, Bland.—Shells which I referred at first to *Z. andrewsi*, W. G. Binney, are undoubtedly *Z. significans*, Bland. They occurred with *sculptilis* and *placentulus*.

26. *Z. multidentatus*, Binney.—This species occurs in the moss in small numbers. Some of the specimens approach, very closely, the previous one.

27. *Vitrinazonites latissima*, Lewis.—This strange mollusk seems to be widely distributed over this region, and ranges from the foot of the Roan plateau, 2,800 feet, to 4,000 feet. It may occur higher, but this is as high as I found it. It lives among the leaves, in damp stations, or under them, on the ground, in dryer ones. It has the habit, so common among the species of *Zonites*, of spreading the foot out over the ground, and extruding a mass of mucus which attaches it, so that, even when the leaves are roughly raked away, the shell remains in its chosen place. This character occurs with *fuliginosus*, *capnodes*, *lævigatus*, *subplanus*, and *friabilis*. In excessively dry stations, on the top of the most barren spurs, these species will occasionally be found as stated above. The generic name given by Mr. Binney was especially well chosen, and there will doubtless be near allies of this remarkable form discovered in the near future.

28. *Patula alternata*, Say.—A very beautiful, nearly smooth variety of this elegant species occurs here. No specimens of the variety *mordax* occurred.

29. *Patula perspectiva*, Say.—The normal type of this species occurs in limited numbers in the same stations as *Z. elliotti*.

30. *Patula bryanti*, Harper.—This curious and rare new form was

found by myself and several members of our party, in various stages of growth. The adult shell is smaller than the average *perspectiva*. The spire is more nearly planiform. The umbilicus is more widely open, and the shell is more depressed below. The open character of the umbilicus and the depression of the spire makes it as easy to determine the number of whorls from below as from above. The whorls increase very gradually in size, and are heavily ribbed above and below, the ribs terminating at a sharp angle on the upper and under outer edge of the body whorl, leaving a space between which is comparatively smooth. The body-whorl is thus rendered distinctly bicarinate, and as the space between the carinæ is comparatively smooth, and not convex, but sloping inwardly from the upper to the lower carina with a plain surface, the periphery of the whorl has a flattened appearance, and the aperture is rendered very nearly quadrate. The upper carina overhangs the plainer, flattened side of the body whorl, and the lower extends beyond it, so that the outer wall of the whorl has a concave external section everywhere, except for a short space immediately back of the aperture. The upper surface of the body whorl is deflected below the upper carina for a short distance back of the aperture.

The station of the species was under rotting logs and in them, being precisely that of *perspectiva*. I always found them solitary, and very rare. *Perspectiva* usually occurs in colonies. The animal is slender, pale bluish white, very sluggish and timid. The tooth on the base of the shell which is a character of *P. perspectiva* is entirely wanting in this species.

31. *Tebennophorus carolinensis*, Boze.—This mollusk was abundant in its usual stations, and presented a great variety in coloration. Its distributions did not seem to be limited by a question of altitude.

32. *Stenotrema stenotremum*, Fir.—Comparatively rare, "spiral lines at base notch strongly developed." Bland.

33. *Stenotrema hirsutum*, Say.—An elevated, somewhat carinated variety, in striking contrast with the globular form so common in Tennessee. A series of figures illustrating the varieties of this species would be of high interest. It differs as much as any species of N. A. *Helix*. This carinated variety has a remarkable development of the notch on the lower lip.

34. *Triodopsis inflecta*, Say.—Rare, occurs with the next.

35. *Triodopsis rugeli*, Shuttel.—Two varieties of this species occur, and what is remarkable are found together. The larger variety is more

than three times the cubic capacity of the smaller, has all the teeth more developed, more bent inward, and the inner upper tooth distinctly reflected toward the base of the shell. It is a very distinct and well marked variety, to say the least of it.

36. *T. tridentata*, Say.—A small, heavily-ribbed, dark-colored variety, occurs sparingly.

37. *Triodopsis fallax*, Say.—A few specimens of the typical form were found.

38. *Succinea obliqua*, Say.—A single dead specimen of this species was found by Miss Mary Wilder, in the heather, at the very summit of Roan High Knob. This aspiring mollusk is the only *Succinea* thus far recorded from this region, so far as I have been able to learn.

The above comprises a complete list of all the species that I have seen from Roan Mountain, though I am satisfied that it is far from being complete. There is a number of small shells, belonging to the Hyalind division of *Zonites* that have not yet been studied. Doubtless varieties of several common species remain to be discovered, and the finding of half a dozen new species by random search during the hot, dry months of summer, by casual visitors, is some evidence that protracted residence and systematic searching would bring to light many new things. From Roan Mountain, and the eastern and older portion of the metamorphic belt, I transferred my theatre of operations to the western region, in the Ocoee Conglomerate, and Slates of Safford, and much farther to the south, in Monroe county, Tenn. Here the whole country is made up of a mass of slates, sandstones, conglomerates, and quartzites, dipping to the southeast at a high angle, and forming many bold and precipitous cliffs where cut through by the Ocoee, Hiwassee, and Tellico rivers in their escape from the mountains to the plains further to the west. In 1877, I took a party of students through the Ocoee gorge to Ducktown, and on the way found typical specimens of *M. major* and of *Z. rugeli*, referring the latter to the globular *inornatus* figured by Mr. Binney. Associated with these specimens was a new species of *Helicodiscus*, of which but very few specimens were obtained, and these were afterward lost or mislaid, so that it was never described. The station was in the debris at the foot of the slate bluffs of the Ocoee. I rediscovered the same species this season, in precisely the same station, in the gorge of Tellico, and was so fortunate as to secure several living specimens, and I now describe it under the name given below.

HELICODISCUS FIMBRIATUS, nov. sp.

Shell light green color, discoidal or planiform, widely umbilicate, consisting of about five whorls, very gradually increasing in size. *Aperture* lunate, and oblique to the axis of the shell. *Peristome* subacute, slightly thickened, and darker than the rest of the shell, the outline somewhat sinuous when viewed from the side of the whorl. *Spire* planiform, not rising above the body whorl. *Suture* deeply and regularly impressed. Umbilicus exhibiting all the volutions. *Whorls* ornamented with from six to eight revolving ridges, terminating in a fringe-like projection of the epidermis, following this arrangement. Two or three of these ridges, on the upper side of the body whorl, are often of such prominence as to give that portion of the shell a fluted appearance. In old shells these epidermal fringes are sometimes worn away, leaving the ridges upon which they stood. Greater diameter 5, lesser 4½, height 1½ mm.

In some specimens as many as six teeth may be observed, none of which can be seen in the aperture.

Remarks.—This shell, from its form and general appearance, at once reminds us of the *H. lineatus*, Say, the only other known species of this somewhat aberrant, but perfectly distinct genus. It has, however, about three times the cubic capacity of its relative, and is very different in sculpturing and ornamentation. The body whorl is slightly deflected for a short distance back of the aperture. It inhabits crevices in the slates of the Ocoee District, where I have found it at the localities above mentioned. The genitalia of this species, of the *H. lineatus*, *Z. subplanus*, *P. harperi*, and other rare shells of this region will form the subject of a future paper.

Z. rugeli, W. G. Binney.—This fine new species, first described by Mr. Binney, from specimens found by Mrs. Judge Andrews, of Knoxville, occurs somewhat abundantly in moist situations about old logs and moss covered rocks, on the flanks of Roan, to a height of 5,500 feet. It grows to a much larger size than Mr. Binney's type, specimens of the larger size being more abundant along the banks of the mountain streams.

This shell is remarkable for its highly polished epidermis, constantly recalling the European *Z. olivieri*, and other species of that group. In this regard it is in striking contrast with the other *Zonites* of like form inhabiting this region. As stated above I found this shell in the Ocoee metamorphics during my trip of 1877.

There is a variety of this shell, or perhaps a distinct species, which

differs in the following particulars. It is less polished; the color is a dark smoky green. The sutures are less impressed, so that the whorls have a peculiar, overlapping appearance. The spire of the shell slopes away as if the whorls had been cut down, removing their outer convexity, and giving the shell a peculiar profile. This may be a variety, only, of *Z. rugeli*, but it is a very distinct one.

Z. andrewsi, W. G. Binney.—This species, which stands in nearly the same relation to *Z. significans*, that the latter does to *Z. multidentatus*, occurs sparingly in the same situations as *Z. rugeli*. An old log in these mountain forests may afford a regular treasure-trove of rare species, if carefully searched, as I have found as many as five or six of the rarer of the above shells in such quarters at once.

I have lately received from a correspondent some fine shells collected at Eureka Springs, Arkansas. Among them are the following varieties worthy of special notice.

M. albolabris, Say.—Specimens of the average size have the spire very much depressed, the aperture correspondingly elongated transversely, and the surface very highly polished. The reflection of the peristome is much narrower, so rendered by its being somewhat folded. It is a very distinct variety, which I have not before seen. There were also, in one of the packages, a var. *minor* of the same species, having the same characters, though somewhat exaggerated. The lip of this variety is very narrow. These two varieties are very interesting, as the station of the shells is on the underside of rocks, a rather abnormal situation of this species which generally inhabits loamy hillsides.

P. dorfeuilliana, Lea.—Together with typical examples of this shell were specimens to which I refer to the variety mentioned by Bland. The shells are much larger than the types. They differ essentially in the umbilical region, so that the merest novice would detect the difference. "The superior tooth on the peristome is larger and more deeply seated than the inferior one, and the latter, though more developed, is much of the same form as in *fastigans* and *troostiana*. The parietal tooth partakes of the general character of that in Lea's type of *dorfeuilliana*, but its lower and terminal margins project more perpendicularly from the parietal walls. I am much inclined to consider this a distinct species."—Bland. I am satisfied that this is a distinct species, or a variety that should receive a distinct name, and I suggest that of *P. sampsoni*, in honor of F. A. Sampson, Esq., who has assiduously and understandingly collected the shells of this interesting region.

P. jacksoni, Bland.—This species is typical, but smaller than specimens from Hematite, Springfield and De Soto, Mo.

M. divesta, Gld.—This locality furnishes typical specimens of this rare species. They have much the coloration and appearance of *M. pennsylvanica*, Green, of which they might at first be taken as a variety. This species inhabits the under side of rocks, with the *M. albolabris* mentioned above.

M. thyroides, Say, var. *bucculenta*, Gld.—This neat little variety, in typical specimens, was collected at this locality by Mr. Sampson. I found it several years ago at Houston and Beaumont, Texas, where specimens frequently occurred with the umbilicus closed. A very peculiar fact connected with these Texas specimens was their beautiful rose color, which has now mostly faded after a lapse of nearly four years.

M. exoleta, Binney, var. *minor*.—A very small, globose, dark-colored variety of this species occurs at this same locality.

T. fallax, Say, var. *minor*. Years ago, I received from Springfield, Mo., a small variety ot this species, much lighter colored, with a thicker and heavier shell than the type. With the peristome reflected backward and rounded, and having a very distinct facies. I have recently received the same variety from Mr. Sampson, who collected it at Eureka Springs.

S. labrosa, Bland.—This comparatively rare species I have from Springfield, Mo., Hematite, Mo., and from Eureka Springs, Ark.

Mr. Sampson also sent me some very interesting species of *Strepomatidæ*, the more interesting because of our comparatively limited knowledge of these shells inhabiting streams west of the Mississippi. The attention of all students of conchology in this region should be called to the desirability of making the fullest possible collections of this family, from all rivers of the west containing them. The whole subject is now in confusion for the want of such collections.

It is to be hoped that collectors of shells, throughout our country, will devote themselves carefully to the study, collection and preservation of local varieties. Imperfect notes, if correct, so far as they go, are better than none. Such facts as the character of the stations, abundance or scarcity of food, comparative average temperature and rain fall ot the region, all questions of habits, circumstances surrounding the reproductive processes, possible hybrids, etc. ; these are questions that any careful observer is competent to undertake, and he will always find at least one correspondent exceedingly grateful for the communication of such observations; and I feel satisfied that the study of this interesting group of animals is now tending in the direction of using

the practical observations of careful persons in working up many of the mysteries clinging to varieties and their causes.

To this end such papers as this may contribute a feeble mite. Laws as yet poorly understood underlie these varieties, and the frequently unexplained mystery of their distribution and association. To the sincere student of this subject these are the topics of highest consequence, because they point out the phylogenic line along which we may hope to trace some of the questions of descent. The molluscan tribes now inhabiting the globe are only the modified remnants of ancestral lines, extending back into the previous ages, and having, no doubt, numerous breaks and changes that might be explained by reference to well understood present laws of life. But how rare the cases in which we have even crossed the threshold of this domain, to say nothing of our absolute want of common knowledge with regard to the rarer vital phenomena common to all animal life. To this end one suggestion, which I do not remember to have seen publicly made, occurs to me here. That all collectors and students of shells, in regions where Post-pliocene species can be obtained, or species from the Loess, especially of the Mississippi Valley, and from dried up lakes, Tertiary basins, etc., make every effort to gather together this material, and to compare notes upon the same. A dead snail, from under an old log or stump is perfectly worthless when abundance of living ones can be had; but a dead shell from a lacustrine or fluviatile deposit, having a greater or less antiquity, is quite another thing, and may teach a lesson of very high value. A correspondent sent me for a long time only dead shells of the *Helicina occulta*. Finally specimens occurred among them so little damaged, that I suggested to him the probability that close search would reveal the living ones. His efforts were successful, now another correspondent sends me thirty or forty living specimens, years after, from a near locality, and among the variety *H. rubella*, Say. Among a lot of dead *Succineas*, quite worthless to the general observer, I found a type of the rare *S. hawkinsii*, Baird. Since then I have been willing to carefully examine, for my correspondent, any such material, in the hope of finding some key to lost or obscure species, to varieties and their causes, and especially to learn, by actual comparison, the changes which species have undergone during long periods of time. If the collector who undertakes this work, will assiduously apply himself to the study of the circumstances of the deposit, and the age of the formation in which his shells occur, and if he has not the necessary knowledge, books of reference and other con-

veniences for comparative study, will communicate these semi-fossil species to those who have, we can, within a few years, have a new and very interesting chapter added to North American conchological literature, and I invite the attention of my brother workers in this field to this suggestion in the hope that some of them may address themselves to the labor systematically; and I shall always be most happy to receive any suggestions, to reply to any questions, and to examine any specimens so collected.

I also call especial attention to another class of shells which I hope to see industriously collected. I refer to the small *Pupas*, *Helices* and *Vertigos*, and to the *Succineas*, *Limnœas* and *Physas*. These shells are unfortunately neglected in comparison to their more fortunate relations of larger size and plainer specific distinction.

They are neglected because it is not always easy to determine the species, and thus because they are "difficult." But I have elsewhere endeavored to show the value of all these circumpolar forms, and subsequent studies, and the accession of large European additions to my collections, have rendered it certain that these very shells will afford us some of the most useful and interesting that can possibly be acquired.

Limnœus and *Physas* should be collected late in the fall, or very early in the spring, or at any time when possible during open winter weather. They will, at such seasons, be found to have the lip hard and perfect. The animals should be carefully extracted, and the shells so packed as to suffer no breaking in transit. A few specimens of each species, from every locality, should always be put into whisky, or alcohol somewhat diluted with water, say one half alcohol. The minute *Helices* can be collected to better advantage in open winter weather than at any other time, since they are collected together in groups for hibernation. Collectors in the west, northwest in the extreme north, and in every region where these shells form the bulk of the conchological fauna, should especially work up these genera with great industry.

Let us remember that the most important object is not the mere fact of amassing a collection, but to have it as perfect an epitome of the groups collected as may be; an object only to be accomplished by persistent endeavor, and that which is intelligently directed.

ZOOLOGICAL MISCELLANY.*

Under the above caption it is proposed to bring together, from time to time, such facts as may be deemed worthy of record, respecting the structure, the life history or the geographical distribution of the various species of animals constituting the Ohio Valley Fauna.

Correspondence from collectors and naturalists generally, is cordially invited, with a view to instituting in this JOURNAL a reflection, so to speak, of the progress of zoological research in the Ohio Valley.

Information in regard to introduced species is especially desired.

MAMMALOGY.

CANIS LUPUS, Linnæus.—*Wolf.*—Through the kindness of Mr. J. W. Shorten, we are enabled to place on record the recent occurrence of this species near Vincennes, Indiana. The specimen, which is an unusually large one, and of the black variety, was shot by a farmer, about the middle of November, 1881, three miles from Vincennes. It had for some time been a terror to the sheep of the surrounding neighborhood.

LUTRA CANADENSIS, Kerr.—*American Otter.*—Dr. Howard Jones, of Circleville, Ohio, informs us of several instances of the occurrence of this species there within the past ten years; the last one having been captured during the winter of 1879-80.

CARIACUS VIRGINIANUS, Gray.—*Virginia Deer.*—The same gentleman, writing under date of January 8, 1881, says that this species is "abundant this winter in the Jackson hills."

ATALAPHA CINEREUS, Coues.—*Hoary Bat.*—We are indebted to Mr. E. R. Quick, of Brookville, Indiana, for a specimen of this species taken by him at that locality, on August 12, 1881. This is the second specimen known from this vicinity, the first, taken near Cold Springs, Ky., being now in the museum of this Society.

SCIURUS CAROLINENSIS var. LEUCOTIS, Allen.—*Northern Gray Squirrel.*—Mr. J. B. Porter, of Glendale, Ohio, writes that the melanotic form of this species, known as the "Black" Squirrel, has been twice identified at that locality, within the past three or four years.

SCIRUS NIGER, var. LUDOVICIANUS, Allen.—*Western Fox Squirrel.*—Mr. Porter also states that the Fox Squirrel is more common than the Gray, a mile or two west of Glendale.

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* Edited by Dr. F. W. LANGDON.

TAMIAS STRIATUS, Baird.—*Chipmunk; Ground Squirrel.*—Dr. D. S. Young notes a habit of this species that does not appear to have been recorded heretofore. The Doctor informs us that many years ago he was eye witness to a struggle between a Ground Squirrel and a Common Frog, at the edge of a small pond in Burnet Woods, the conflict finally ending by the frog being bitten through the head. At this stage of the proceedings the squirrel was frightened off, so that the evidence of its carnivorous propensities, while strong, is merely presumptive.

HESPEROMYS LEUCOPUS, Leconte.—*White-footed* or *Deer Mouse; Field Mouse.*—I have a beautiful specimen of the Field Mouse (*Hesperomys leucopus*), which is a perfect albino, with red eyes. It is alive and bears confinement well, having become very tame, so much so that it will take food from my hand. When first taken it was perfectly white, but now is of a slight creamy tinge. It has some curious traits, one of which is that if a finger is placed at an opening in the cage, it brings leaves from the nest in which it sleeps, and places them against the intruder, as if to shut it out.—EDGAR R. QUICK, Brookville, Franklin Co., Indiana.

ARCTOMYS MONAX, Schreber.—*Woodchuck; Ground Hog.*—We have the following additional testimony as to the arboreal habits of this species. "I have repeatedly shaken them from saplings, and have seen them in trees of considerable size." * * * "It is a common belief among the country people that it is a sign of rain to see a Ground Hog in a tree. So confident are they in this opinion that I have seen one rustic bet twenty-five dollars' worth of property on the sign. On this occasion it did not rain for two weeks after the ascent of the 'Hog.'"—HOWARD JONES, M. D., Circleville, Ohio.

LEPUS SYLVATICUS, Bachman.—*Gray Hare; Rabbit.*—Writing of this species, Dr. Howard Jones says, "our rabbit lives in burrows to a very large extent. A fellow here hunts them with ferrets like they do the English Hare (rabbit—ED.) Sometimes, he tells me, as many as ten come into the bag from one hole. That many of them live in burrows, I have long known; whether or not they dig them themselves, I am ignorant."

ORNITHOLOGY.

HELMITHERUS VERMIVORUS, Salv. & Godm.—*Worm-eating Warbler.*—Mr. E. R. Quick has observed this species to be quite common near Brookville, Indiana, as early as April 22 (1881).

HELMINTHOPHAGA CHRYSOPTERA, Baird.—*Golden winged Warbler.*—Of this species, which has hitherto been considered rather rare in this vicinity, six specimens were taken between May 2d and 5th, 1881, at Brookville, Indiana, by Messrs. E. R. Quick and A. W. Butler.

HELMINTHOPHAGA PEREGRINA, Baird.—*Tennessee Warbler.*—The fact that fall specimens of this species, in this locality at least, are almost invariably characterized by an abrupt whitish tipping of the primaries, seems to have been entirely overlooked by writers; at least we have been unable to find any reference to this feature. Its presence also suggests the query, are the primaries moulted twice a year, or is the whitish tipping simply due to an incomplete or transition stage of pigmentation, which is fully developed by the following spring, when the feathers are brownish to their tips? The latter view certainly seems the more probable of the two.

GEOTHLYPIS PHILADELPHIA, Baird.—*Mourning Warbler.*—Specimen taken May 7, 1881, at Brookville, Indiana, by A. W. Butler.

STELGIDOPTERYX SERRIPENNIS, Baird.—*Rough-winged Swallow.*

CERYLE ALCYON, Boie.—*Kingfisher.*

On May 22, 1879, we took from their burrows, in the bank of a dry creek, the nests of a Rough-winged Swallow, and of a Kingfisher, each of which was presided over by one of its owners. Each burrow was, in addition, inhabited by a colony of Humble Bees, members of which were passing in and out continuously, seemingly in perfect harmony with the feathered occupants of the burrows; and it is worthy of note that the *Hymenopterous* denizens "held the fort" with better credit to themselves, and more impression on the attacking party, than did either of the birds. In justice to the Kingfisher, however, it should be noted, that the male, who was incubating the eggs at the time, refused to leave even when urged to do so with a stick; and, finally, had to be seized by the bill and lifted off the eggs.

On May 22, 1879, Mr. Charles Tompkins, of Madisonville, Ohio, took from a crevice in the wing-walls of a culvert, a nest of *S. serripennis*, containing seven eggs, the largest number we have yet observed in a set. Of a dozen or more nests of this species, taken on the same dates (May 20-21), those from inland situations (along creeks and bridges) were complete in number (5 to 7), and well advanced in incubation; while those from river banks were, with one or two exceptions, incomplete, containing only from one to four eggs, which in all cases were fresh.

LANIVIREO SOLITARIUS, Baird.—*Blue-headed or Solitary Vireo.*—Noted by Mr. Quick as "common" at Brookville, Indiana, on May 2, 1881.

PASSER DOMESTICUS, Leach.—*European House Sparrow.*—On August 29, 1880, we picked up a specimen of this species at Madisonville, which, although exhibiting no mark of injury, was evidently in a dying condition. It lived about half an hour after coming under observation, and during that time was subject to convulsive paroxysms at intervals of a few minutes. An autopsy immediately after death revealed the following conditions: Liver very soft, friable, and of a dusky, olivaceous brown color, resembling the "bronzed" hue which occurs in the human liver and other organs, as a consequence of chronic malarial poisoning. Kidneys also discolored in the same manner, but to a less extent. Other organs normal; no marks of violence anywhere.

COTURNICULUS PASSERINUS, Bonaparte.—*Yellow-winged Sparrow.*—Under date of July 25, 1880, Mr. Charles Dury writes as follows: "June 26 (1880), I saw and heard many Yellow-winged Sparrows, and took one nest and four eggs (incubation begun)." This was in some meadow land west of Lockland, Ohio, and adds a species to the list of those known to breed in this vicinity, which now numbers (including those added in the present paper), eighty-five.

SPIZELLA PUSILLA, Bonaparte.—*Field Sparrow.*—A specimen in the writer's cabinet (No. 1,037), taken at Madisonville, Ohio, August 26, 1878, exhibits a globular tumor, the size of a large pea, involving the forehead and the upper mandible to its tip. The growth had probably to some extent affected the cerebral functions as was evidenced by the irregular flight of the bird which first attracted our attention; and also by the fact of its capture by hand with little difficulty, although the wings and other parts were entire.

Another specimen (No. 1,058 F. W. L.) taken at Madisonville, Sept. 28, 1878, exhibits partial albinism—one of the secondaries being pure white.

A third specimen of the same species (No. 800, F. W. L., Madisonville, Oct. 28, 1877), presents a tumor the size of a small pea, at the distal extremity of the middle toe.—(ED.)

PEUCÆA ÆSTIVALIS ILLINOISENSIS, Ridgway.—*Oak-woods Sparrow.*—We are in receipt of the following interesting note respecting the occurrence of this species, about one hundred miles southwest of Cin-

cinnati. "I send, agreeably to your request, by this mail, my specimen of *Peucæa æstivalis*, the only one I have ever taken. It was captured April 28, 1877, about five miles northeast of Bardstown, Nelson county, Ky., by myself. My attention was attracted by a succession of low and rather sweet notes, entirely unfamiliar to me, which after some little trouble I traced to this bird, sitting on a low limb of a small oak, just on the edge of a field. I have never seen or heard it again."—C. W. Beckham, Bardstown, Nelson county, Ky.

On examining Mr. Beckham's specimen, which he kindly sent to us for that purpose, we find it to correspond closely with Mr. Ridgway's description of the geographical race named by him *illinoisensis*,* and hitherto only recorded from Alabama, Texas and Illinois. Mr. Beckham's capture, therefore, is of much interest, as being the most eastern record of this form, and as considerably extending the known range of the genus (Ed.)

Cardinalis virginianus, Bonaparte.—*Cardinal Grosbeak.*—This species has been observed nesting as late as August (1881), at Glendale, Ohio, by Mr. J. B. Porter, the eggs hatching on the 20th and 22d of that month.

Eremophila alpestris, Boie.—*Shore Lark.*—Under date of July 9, 1880, Mr. H. E. Chubb, of Cleveland, Ohio, writes that he found the Shore Lark breeding "quite abundantly" at that locality.

Empidonax flaviventris, Baird. — *Yellow-bellied Flycatcher.*—The probability that this species occasionally breeds here is suggested by the capture of a specimen at Madisonville, on May 28, 1879, at which time several nests of *E. acadicus* were observed to contain their full complement of eggs.

Ceryle alcyon, Boie.—*Belted King-fisher.*—(See page 338.)

Aluco flammeus americanus, Ridgway.—*American Barn Owl.*—Specimen taken near Circleville, Ohio, in the summer of 1874.—Howard E. Jones, M.D., Circleville, Ohio.

Nyctea scandiaca, Newton.—*American Snowy Owl.*—Mr. E. R. Quick's cabinet contains a fine specimen taken near Brookville, Ind., in December, 1879.

Archibuteo lagopus sanctijohannes, Ridgway.—*Rough-legged*, or *Black Hawk.*—Specimen taken at Glendale, Ohio, December 23, 1880; the second known from this vicinity.—J. B. Porter.

Catharista atrata, Less.—*Black Vulture*; *Carrion Crow.*—Two

* Bulletin Nuttall Ornithological Club, vol. iv., p. 219. *Ibid*, vol. v., pp. 52 and 89.

specimens observed at Brookville, Indiana, May 17, 1879, in company with a number of Turkey Buzzards.—E. R. QUICK.

BONASA UMBELLUS, Stephens.—*Ruffed Grouse; Pheasant.*—The oviduct of a specimen taken by the writer at Brookville, Ind., May 10, 1879, contained an egg on which the shell had begun to form.

ORTYX VIRGINIANA, Bonaparte.—*Quail; Bob White.*—Rev. G. W. Dubois informs us of an instance, which came under his observation, of the joint ownership of a nest by a Quail and a common hen. The incident occurred near Morrow, O., in the summer of 1878. Which bird took final charge of the chicks is not stated.

(PHILOMACHUS) MACHETES PUGNAX, Cuvier.—*The Ruff.*—The occurrence of this European species in Ohio may not be generally known to collectors. A specimen from Licking Reservoir, thirty miles east of Columbus, is recorded by Dr. J. M. Wheaton, in the *Bulletin of the Nuttall Ornithological Club*, vol. ii., p. 83.

ACTODROMAS MACULATA, Coues. —*Pectoral Sandpiper.*—Mr. J. B. Porter informs us of the capture of twenty-one specimens of this species, July 29 and 30, near Glendale, O.

BARTRAMIA LONGICAUDA, Bonaparte.—*Bartram's Sandpiper; Upland "Plover."*—Seven specimens taken July 29, 1880, near Glendale, O., by Mr. J. B. Porter, who thinks the species had bred there.

TANTALUS LOCULATOR, Linnæus.—*Wood Ibis.*—Under date of July 9, 1880, Mr. H. E. Chubb, of Cleveland, Ohio, advises us that he has added to his cabinet a Wood Ibis shot near that place on June 20, 1880.

CHEN HYPERBOREUS, Boie.—*Snow Goose.* — Specimen taken near Brookville, Franklin county, Ind., on October 18, 1881, in company with a flock of tame geese.—E. R. QUICK.

HARELDA GLACIALIS, Leach.—*Long-tailed Duck; Old Squaw.*—A specimen taken near the mouth of the Great Miami, on February 24, 1880, by Mr. T. J. Baum, is now in that gentleman's cabinet. This capture, while adding a species to the list of birds identified in this vicinity (which now numbers 264), is also of interest as considerably extending the known eastward range of this duck in the Mississippi Valley. We are indebted to Miss Emma Goepper for the facts relating to its capture.

PHALACROCORAX DILOPHUS, Nutt, *Double-crested Cormorant.*——Mr. E. R. Quick has sent us an example of this species taken by him at Brookville, Ind., on November 19, 1880. A specimen, now in the museum of this society, was taken by Mr. Harry Hunt, on October 20, 1881, about four miles above the mouth of the Great Miami.

Introduction of European Birds.

We are indebted to Mr. Andrew Erkenbrecher, president of the late Acclimation Society of Cincinnati, for the following information regarding this subject.

During the years 1872, '73 and '74, about nine thousand dollars were expended in the purchase and importation of European Birds, their average cost to import being about four dollars and fifty cents a pair. According to this estimate, some four thousand individuals were introduced, representing the following species :*

Robin Redbreast (*Erythaca rubecula*).†
Wagtail (*Motacilla yarrellii ?*).
Skylark (*Alauda arvensis*).
Starling (*Sturnus vulgaris*).
Dunnock (*Accentor modularis*).
Song Thrush (*Turdus musicus*).
Black Bird (*Merula vulgaris*).
Redwing (*Turdus iliacus*).
Nightingale (*Philomena luscinia*).
Gold Finch (*Carduelis elegans*).
Siskin (*Carduelis spinus*).
Great Tit (*Parus major*).
Dutch Tit.
Dipper (*Cinclus aquaticus*).
Hungarian Thrush.
Bull Finch (*Pyrrhula vulgaris*).
Cherry Bird.
Missel Thrush (*Turdus viscivorus*).
Corn Crake (*Crex pratensis*).
Crossbill (*Loxia curvirostra*).

While we deem the above facts of sufficient ornithological importance to merit a record in permanent form, and can not but admire the sentiment which prompted the introduction of these birds, we may properly, at the same time, express the opinion that the general principle is, zoologically speaking, a wrong one, and that its application is, in many instances, absolutely harmful, economically considered.

Nature knows best how to balance her own forces ; and the animal and vegetable life of any country is usually equal to the capacity of

* *Vide* Forest and Stream, June 4, 1874.

† The technical names are supplied where it is practicable to recognize the species from its common name.—(Ed.)

that country to support it. Consequently, to maintain this natural balance, if introduced species, finding the environment favorable, increase, they can only do so at the expense of the native ones ; and illustrations of this proposition are seen in the effect of the introduction here of the Canada Thistle, Whiteweed, Cabbage Fly, European Sparrow, House Mouse, Norway Rat, and so on up to man himself.

Practically, in the case of the introduced birds, the question seems to have solved itself as follows : The European Sparrow, belonging to a family (the *Fringiliidæ*) already represented in this locality by 29, and in North America by 127 species and varieties—finding here an environment suited to its needs, has rapidly increased in numbers. In some localities this increase has been evidently at the expense of birds of similar nesting habits, but belonging to other families,—as the Wrens, Swallows, Martins, Bluebirds, etc.

On the other hand, in favor of the Sparrows, may be adduced the fact that we now have birds where we formerly had none, *i. e.*, in the streets of our large cities ; here the Sparrow lends an attractive air to the monotony of brick walls and cornices, even if he does disfigure the latter with his bulky nests, and scatter his lateritious cards somewhat too numerously over our window sills and doorsteps.

As regards the insectivorous birds (Thrushes, Warblers, Tits, etc.) —of which class there are already about 160 species in North America —the imported ones have not, so far, exhibited the tendency to increase manifested by their gramnivorous relatives, and consequently their influence on native species has been practically negative.

The moral of these facts and figures seems to be—take care of what birds we have, by a judicious preservation of thickets and other abiding places, and nature will provide effectually against the calamity of an ornithological vacuum.

HERPETOLOGY.

Cistudo clausa, Gmelin.—*Common Box Tortoise.*—Remains of this species are quite common in the Madisonville Ancient Cemetery, the carapace being occasionally perforated, evidently with a view to use as a badge or ornament.

Aspidonectes spinifer, Agassiz.—*Common Soft-shelled Turtle.*—Remains found in the ashpits of the Madisonville Ancient Cemetery.

Rana temporaria sylvatica, Gunther.—*The Wood Frog.*—On March 10, 1879, we observed large numbers of this species in some small ponds near Madisonville, Ohio, and as the species seems to be

rather imperfectly known in many respects, a few notes as to its habits and apperance at that (the breeding) season, may be an acceptable contribution to its life history.

They were quite abundant at the time and place above mentioned, swimming about at the surface of the water, and uttering a peculiar croak which somewhat resembled the "tchauk" of the Rusty Grakle, and again making a sound very like the low quackling of the domestic duck.

The females, which are much larger than the males, and of a different color, were also out numbered by them, there being, as nearly as could be determined, about four or five males to one female. Each female had from three to five males hanging on to various available points of her anatomy, there being often one to each leg, and a fifth clasping the neck, and when any one of them was picked up out of the water, so pre-occupied were they all for the time being, that the entire bunch hung together for several seconds, finally letting go their holds and dropping back into the water one by one. By March 15 they had entirely disappeared from the ponds, probably to resume their sylvan life, as the species is known to be aquatic only during the reproductive season. As the species has been rather unsatisfactorily described heretofore (the male having apparently been overlooked altogether), and as there are marked differences between the sexes, both in size and in coloration, a description of both sexes is subjoined.

MALE.—Above, very dark olive brown; below, soiled greenish or yellowish-white. A dorsal line extending from center of forehead along anterior two-thirds of back, soiled whitish. Dorsal surface of thigh, leg and foot, each with three diagonal bands of blackish brown. A black line from eye through nostril, gradually narrowing toward its anterior extremity. A triangular black patch extends downward and backward from the inferior orbital margin, and incloses the tympanum. Eyes, prominent; iris, golden yellow above and below, black at outer and inner segments. Feet, full-webbed; toes, five, the fourth much the longest and stoutest. Fingers, four, the first much thickened, and presenting the appearance of two grown together. Length of head, body and outstretched hind leg, 5½ inches.

FEMALE.—Much larger than male. Above, dingy pinkish red. Four diagonal transverse bands of blackish on thigh, three on leg, and three on foot. Head markings as in the male. Length of head, body and outstretched hind leg, 7 inches.

ICHTHYOLOGY.

PERCA FLAVESCENS, Cuvier.—*Common Yellow Perch.*—The palatines of this species, studded with their peculiar villiform teeth, are of very frequent occurrence in the "ashpits" of the Madisonville Ancient Cemetery. At the present day the species is far from being a common one in the adjoining (Little Miami) river, and seldom attains the dimensions indicated by the remains found in the above cemetery.

CONCHOLOGY.

SPHÆRIUM OCCIDENTALE, Prime.—This species, which has not previously been recorded from the immediate vicinity of Cincinnati, was found on April 22, 1877, in the "Ferris Ponds," near Madisonville, Hamilton county, O.—R. M. BYRNES, M.D., Cincinnati, O.

VIVIPARA CONTECTOIDES, Say.—On May 6, 1877, about twenty individuals of this species were "planted" by the writer, at the request of Dr. R. M. Byrnes, in the small body of water known as "Bramble's Pond" near Madisonville, Ohio. The record is made for the benefit of future conchologists who may happen upon the species here.—(ED.)

ENTOMOLOGY.

CALLOSAMIA PROMETHEA, Drury—*Sassafras Moth.*—On October 8, 1876, we observed the cocoons of this species hanging from a number of "Button Bushes" (*Cephalanthus occidentalis*) growing in a small pond near Madisonville, Ohio, and have since observed them repeatedly on the same shrub. As the bushes were surrounded by water from one to three feet in depth, and not in contact with other plants likely to be the food of this species, the inference is unavoidable that the eggs were laid, and the larvæ reared where the cocoons were found. We have also taken the cocoons of this species on the Tulip tree (*Liriodendron tulipfera*, L.) So far as known to the writer the species has not hitherto been recorded as feeding on either of the above plants. In this locality the imago emerges July 10 to 17, the females preceding the males by a few days.

BOTYS LANGDONALIS, Grote.—*Langdon's Moth.*—This species, first described by Prof. Grote, in the Canadian Entomologist, for January, 1877, from a single specimen taken by the writer, at Madisonville, Ohio, has since been taken by Mr. C. F. Low, at the same locality. It was observed by him, on August 10, 1879, in considerable numbers at dusk, flying about the edge of a tract of woodland; in company with it

were several individuals of *Botys flavidalis.* He has also taken a single specimen at Madisonville, on June 4 (1879), so that the fact that the species is double-brooded in this locality, may be considered as established. Mr. Charles Dury has taken several specimens at Avondale, Ohio, during the past two or three seasons.

Mr. Low describes its flight as consisting of short sallies of from ten to twenty feet, after which it would alight on the under surfaces of leaves.

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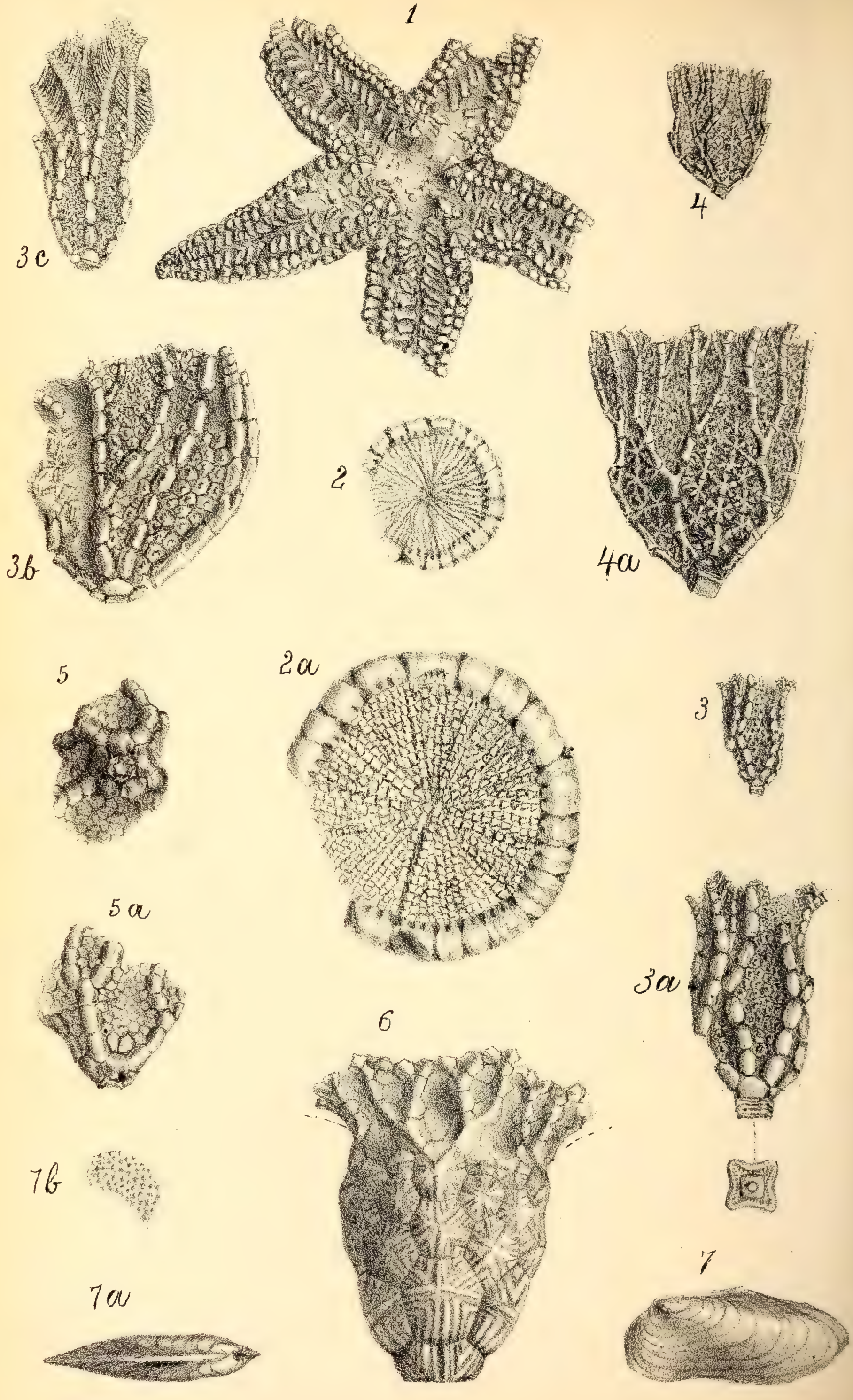

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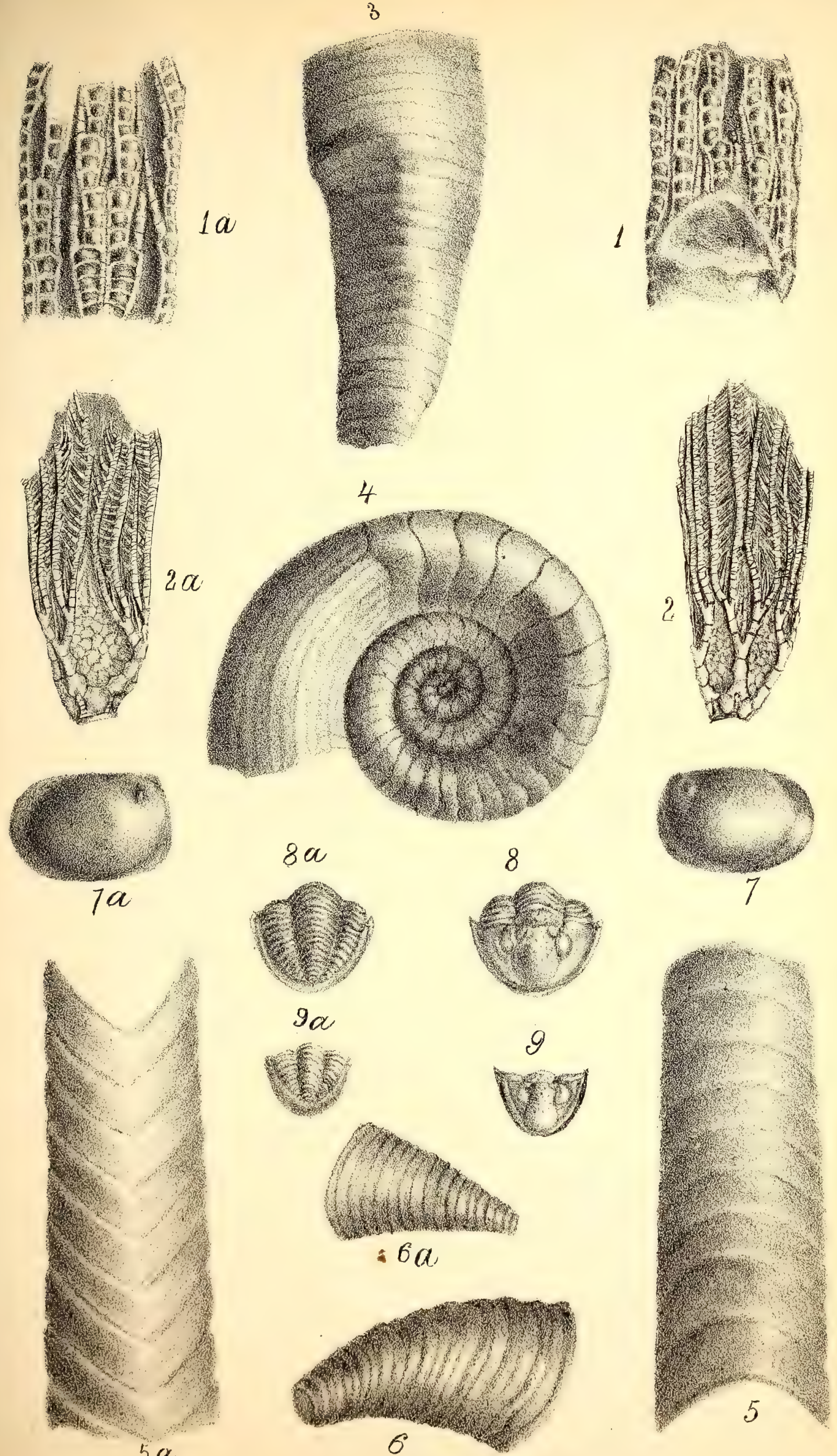

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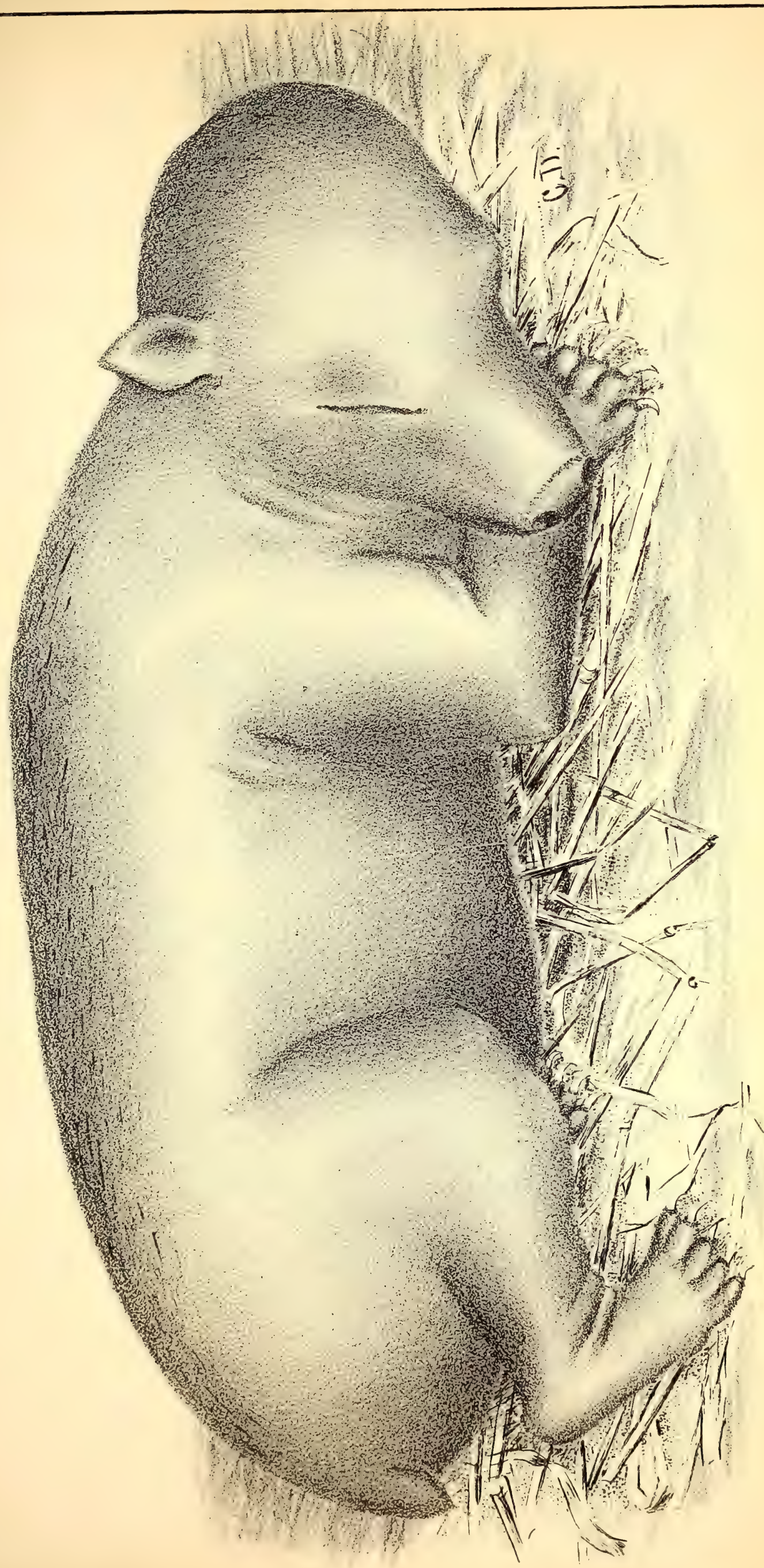

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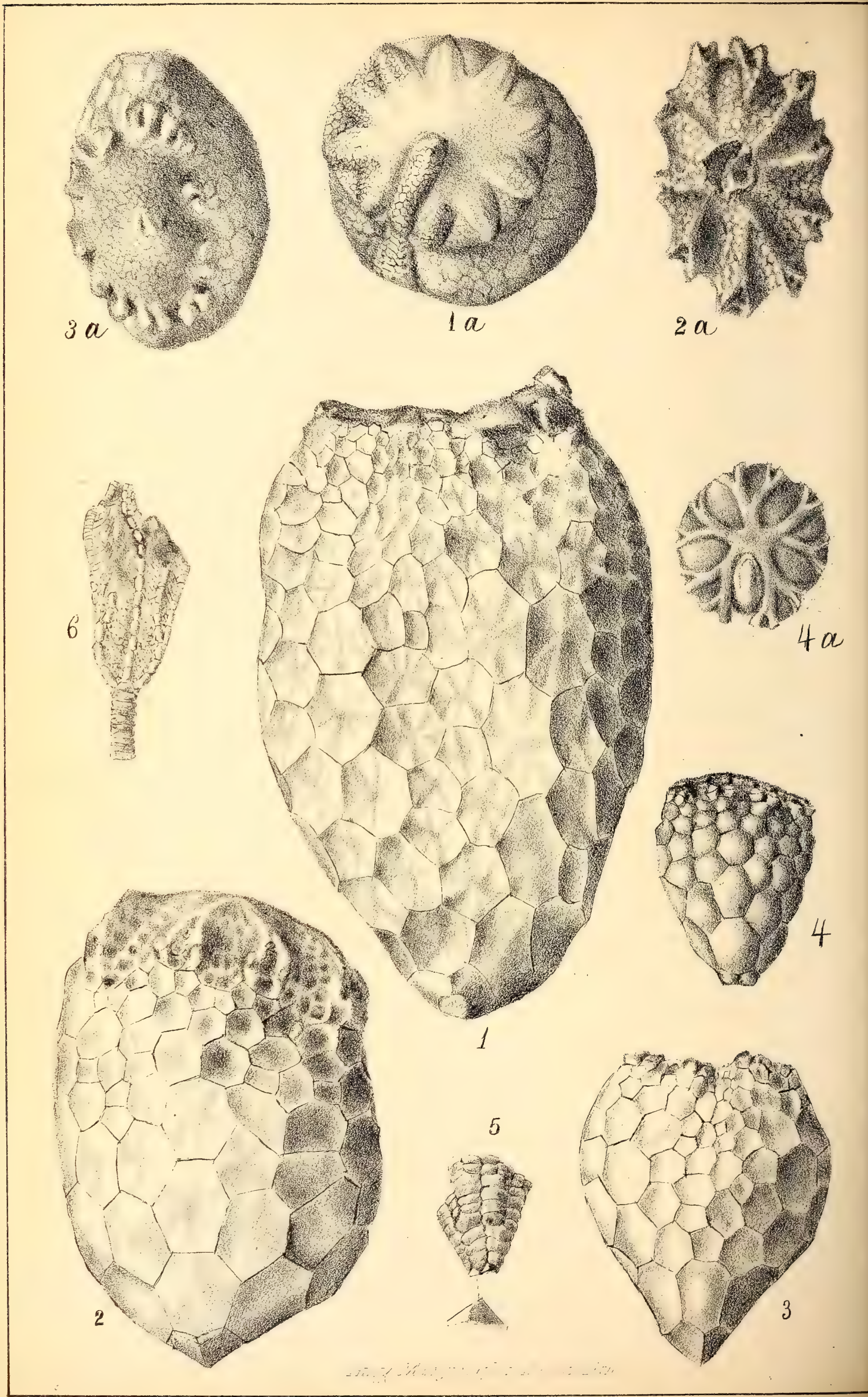
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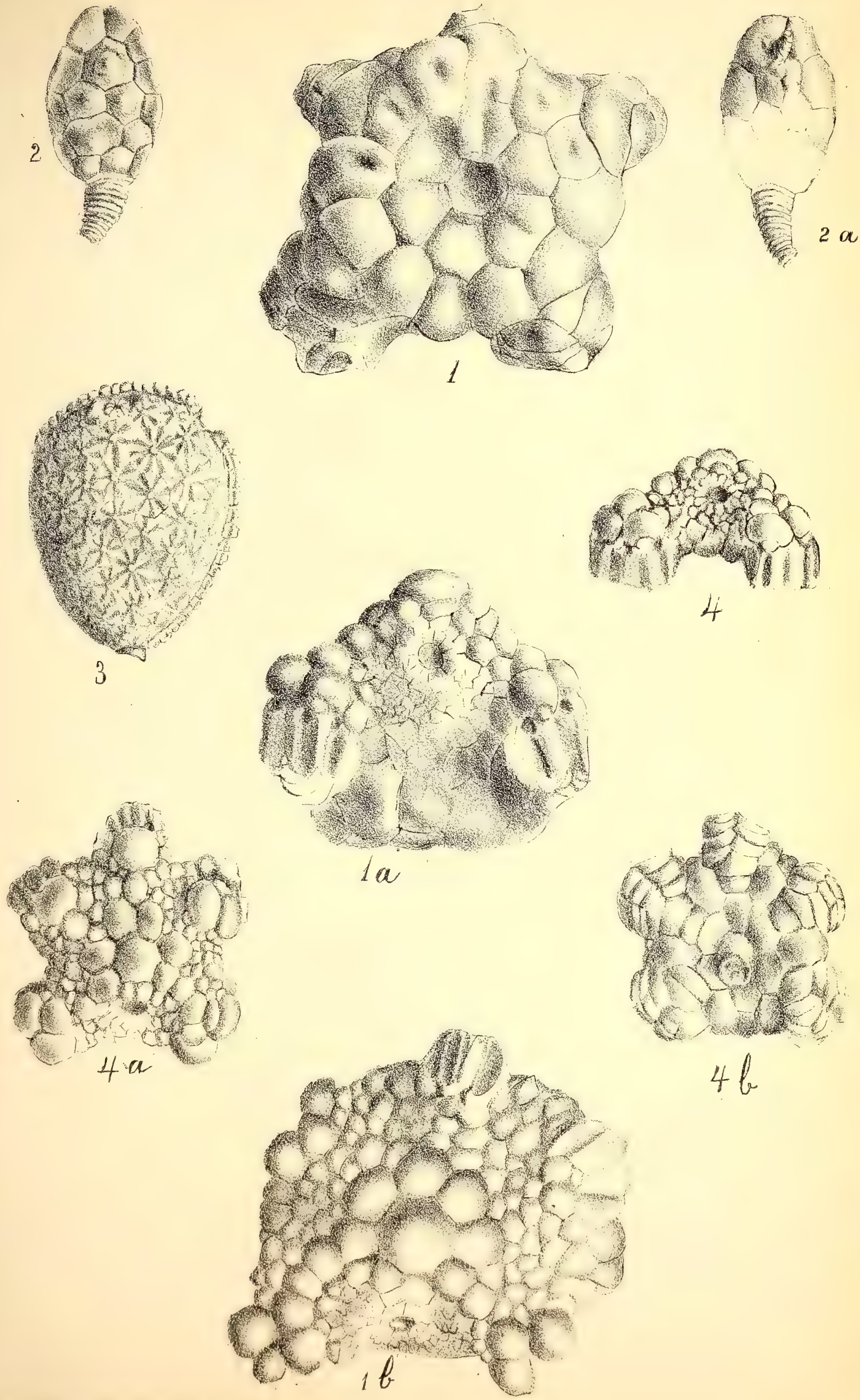
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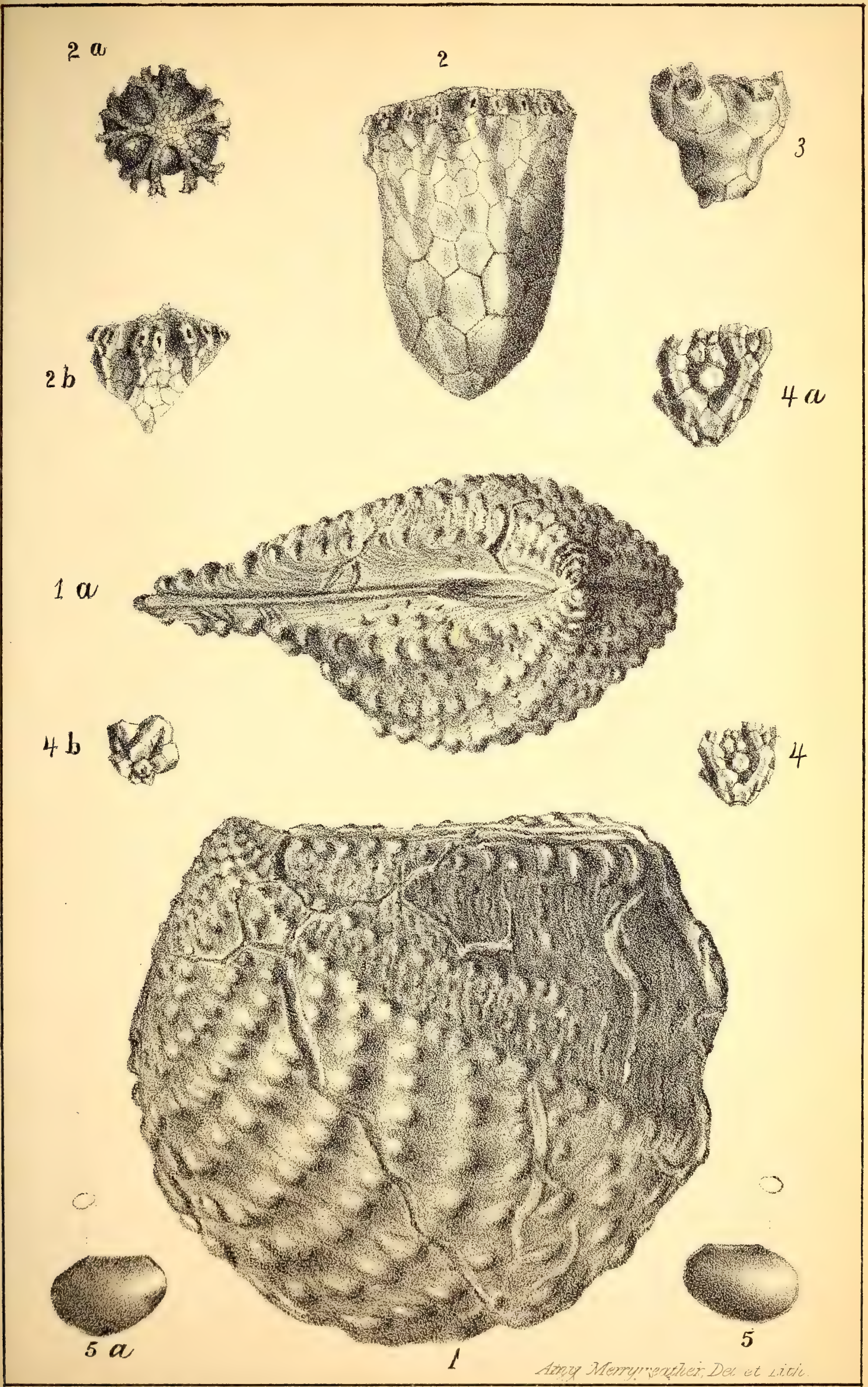
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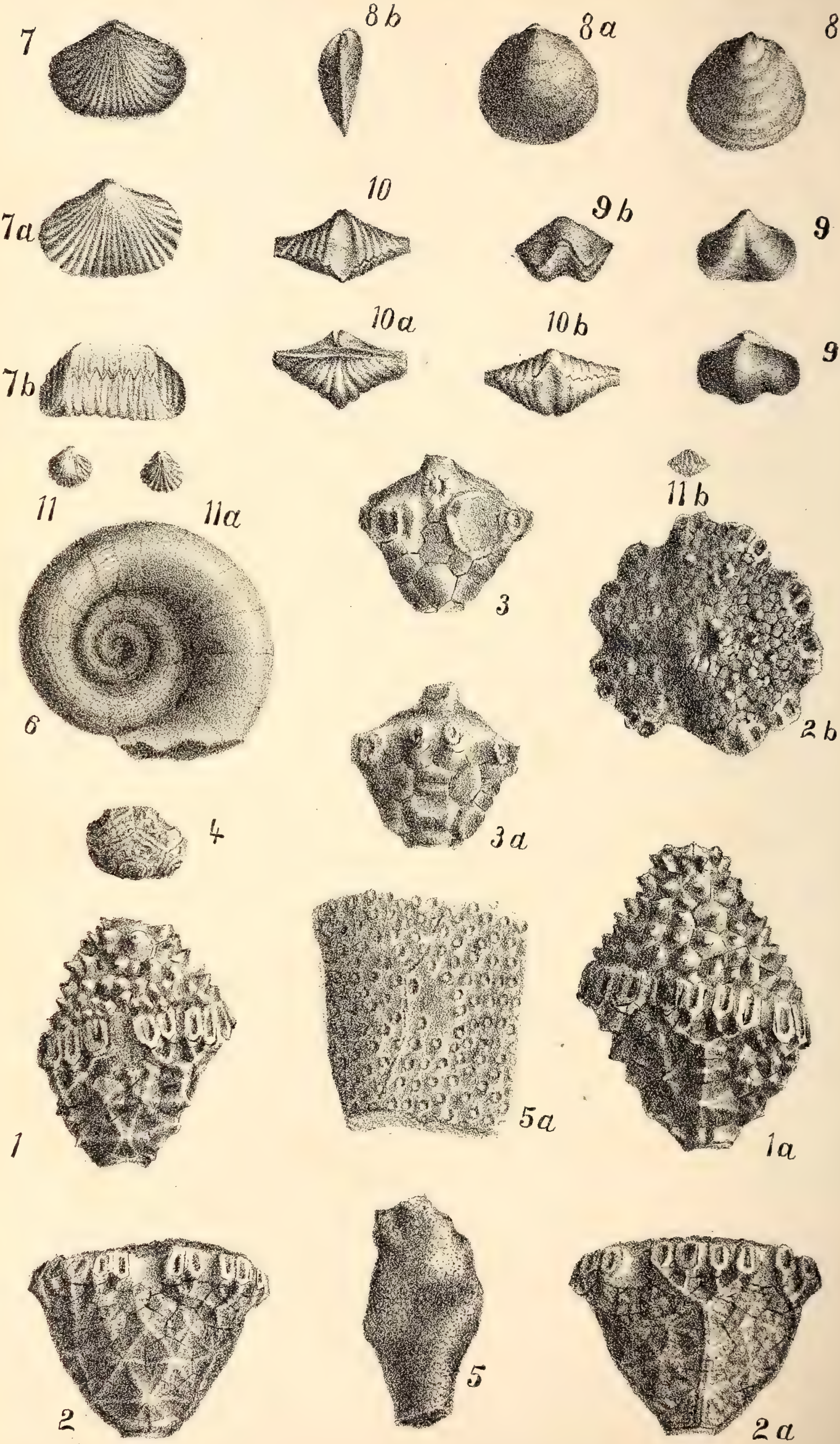

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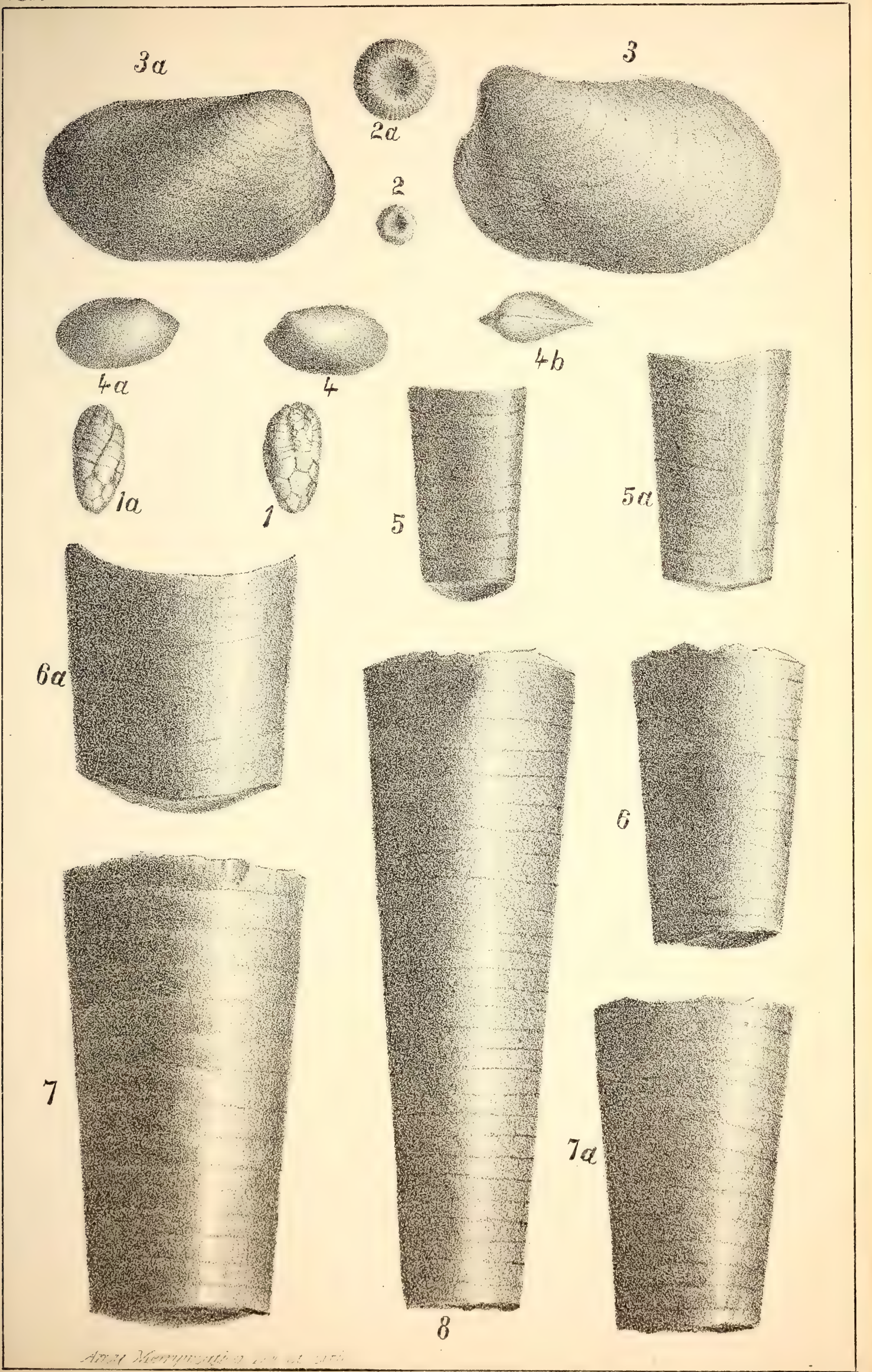
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